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ABSTRACT

This curriculum guide outlines three credits of study, one credit for each of the grade levels 10, 11, and 12. Intended as an optional study area for all students, the program provides awareness and exploration for those students who aspire to postsecondary study and introduces skills to those who wish to explore trades and technologies in employment after school. The program assumes that students who enter the program area will begin study at the 101 level. Each level has core modules and option modules that offer flexibility. Metalwork 201 is designed to expand the student's knowledge and experience in metalworking through a design technology approach. Metalwork 301 is designed to enable the student to achieve extended pretechnical and personal enrichment goals. Introductory materials include an overview, information on implementation, and goals and objectives. Fifteen modules are provided. Each has these components: major objective, student objectives, teachers' notes and suggested activities, and suggested materials. Module titles are student orientation and safety, product planning, measurement and use of instruments, basic machine tool technology, basic arc welding, basic oxyacetylene welding, sheet metal, bench metal, foundry practice, forging practice, metallurgy and basic heat treatment, art metal, advanced welding, advanced machine tool technology, and modern industry. A nine-page bibliography is provided, including a five-page list of audiovisual materials available in the Manitoba Education Library; 19 publishers are also listed, with addresses.(Y LB)

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Manitoba Education

1987

industrial arts

metalwork 101, 201, 301

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101, 201, 301

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This guide has been developed as part of the revision for Industrial Arts curricula for grades 7 through 12 in Manitoba schools, and replaces the Industrial Arts 10-12 Metalwork guide of 1968. This guide has been based upon recommendations provided by the Industrial Arts 10-12 Steering Committee, and prepared as a result of recommendations to proceed with this project by the Curriculum Policy Review Council.

The Metalwork 101, 201, 301 Industrial Arts Senior High Curriculum Ad Hoc Committee provided the writers with the necessary technical and pedagogic support in reviewing the curriculum throughout its development.

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overview

OVERVIEW

INTRODUCTION

The Industrial Arts 10-12 Metalwork curriculum guide outlines three credits of study, one credit for each of the grade levels 10, 11, and 12. Several general features have been integrated throughout the guides:

1. Industrial Arts provides learning opportunities for the wide-ability range of learners;

2. Career exploration and planning is incorporated into Industrial Arts programs;

3. Industrial Arts at the secondary level assumes that students have had no junior high school exposure to the program area; and

4. Basic and generic skills include problem solving, creative designing, and decision making.

This program should be viewed as an optional study area for all secondary students. It provides awareness and exploration for those students who aspire to post-secondary study, as well as introduces skills to those students who wish to explore trades and technologies in employment after school. The avocational use of basic and generic skills serves the entire spectrum of students.

Schools are encouraged to make special efforts to include in Industrial Arts programs students who would normally perceive this area as traditionally suited to persons of the opposite sex. It is especially possible for the practical arts to play an important role in reversing sex-role stereotyping.

RATIONALE

Metalwork 101, 201, 301, with its "hands-on" emphasis, has been designed to provide students with the opportunity to develop generic skills. Specifically, the Metalwork program offers experiences in the following areas:

- planning,
- designing,
- measuring,
- assessing and estimating costs,
- systematizing,
- evaluating,
- adjusting and diagnosing,
- problem solving,
- decision making

Generally, Metalwork 101, 201, 301 allows the student a flexible curriculum through which one can exercise time management, quality control, and teamwork.

This curriculum guide is a statement of INTENT, CONTENT, and DEPTH of study. It is prepared for the teacher as a guideline rather than a mandatory prescription. While teachers are invited to develop their course of study around this curriculum guide, it is ultimately left to them to assess and prepare their courses in accordance with their preferences for emphasis, the nature of facilities, their perception of student needs, school and administration philosophies, and community requirements. The use of CORE and OPTION modules is recommended to help the teacher accommodate the variables affecting the program.

STRUCTURE OF THE PROGRAM

Metalwork 101, 201, 301 assumes that students who enter the program area for the first time will begin study at the 101 level. Each level has CORE modules which must be studied to the extent set by the teacher, and OPTION modules which offer the flexibility described in the Rationale for this course.

SENIOR HIGH METALWORK

Module Title	Page
01 Student Orientation and Safety	25
02 Product Planning	32
03 Measurement & Use of Instruments	37
04 Basic Machine Tool Technology	42
05 Basic Arc Welding	59
06 Basic Oxy-Acetylene Welding	67
07 Sheet Metal	83
08 Bench Metal	91
09 Foundry Practice	99
10 Forging Practice	105
11 Metallurgy & Basic Heat Treatment	109
12 Art Metal	119
13 Advanced Welding	123
14 Advanced Machine Tool Technology	133
15 Modern Industry	143

METALWORK 101

Module Title	Core-C Option-O	Page
01 Student Orientation and Safety	C	25
02 Product Planning	C	32
03 Measurement & Use of Instruments	C	37
Minimum of FOUR of the following SEVEN:	C C C C	
04 Basic Machine Tool Technology		42
05 Basic Arc Welding		59
06 Basic Oxy-Acetylene Welding		67
07 Sheet Metal		83
08 Bench Metal		91
09 Foundry Practice		99
10 Forging Practice		105

METALWORK 201 is designed to expand the student's knowledge and experience in metalworking through a design technology approach. With this approach, the end product or project is considered secondary to an understanding of how it was produced, and original design is encouraged within the limits of previous experience and knowledge gained in Metalwork 101.

In addition to serving as an extension or continuation of competencies developed in Metalwork 101, this level could provide in-depth experiences in a rather specialized phase or area of technology.

METALWORK 201

Module Title	Core-C Option-O	Page
01 Orientation and Safety	C	25
02 Product Planning	C	32
03 Measurement & Use of Instruments	C	37
MINIMUM of FOUR of the following SEVEN: (DESIGN PROBLEM APPROACH BASED ON MODULES COVERED IN METALWORK 101)	C C C C	
04 Basic Machine Tool Technology		42
05 Basic Arc Welding		59
06 Basic Oxy-Acetylene Welding		67
07 Sheet Metal		83
08 Bench Metal		91
09 Foundry Practice		99
10 Forging Practice		105
MINIMUM--TWO OTHER MODULES i.e.: a) Two of 04-10 not covered in 101, or b) Two of 11-14, or c) Combination thereof	C C	
11 Metallurgy & Basic Heat Treatment		109
12 Art Metal		119
13 Advanced Welding		123
14 Advanced Machine Tool Technology		133

METALWORK 301 is designed to enable the student to achieve extended pre-technical and personal enrichment goals. In general, emphasis should be placed on the following:

- Developing additional specific metalworking skills and techniques;
- Learning industrial technology by understanding the enterprise system and by mass producing and marketing products;
- Experimenting with problem-solving, research and development in regard to any specific topic to metalwork production;
- Developing creativity and avocational opportunities through individually designed/produced products;
- Developing awareness of career opportunities and familiarization with occupational requirements, practices and standards.

METALWORK 301

Module Title	Core-C Option-O	Page
01 Student Orientation and Safety	C	25
02 Product Planning	C	32
03 Measurement & Use of Instruments	C	37
15 Modern Industry	C	143
MINIMUM--THREE Modules not covered in 101 and 201	C C C	
04 Basic Machine Tool Technology		42
05 Basic Arc Welding		59
06 Basic Oxy-Acetylene Welding		67
07 Sheet Metal		83
08 Bench Metal		91
09 Foundry Practice		99
10 Forging Practice		105
11 Metallurgy & Basic Heat Treatment		109
12 Art Metal		119
13 Advanced Welding		123
14 Advanced Machine Tool Technology		133

implementation

IMPLEMENTATION

SAFETY

Industrial Arts courses, being practical and "hands-on" in nature, require that schools and teachers plan implementation strategies with care to safety concerns. Throughout this guide, special mention is made of safety concerns with regard to higher-risk activities. However, SAFETY IS A CONCERN AT ALL TIMES, and it is the responsibility of those who deliver the courses to ensure that adequate and reasonable safety precautions are taken.

TIME ALLOTMENT

Metalwork 101, 201, and 301 are considered to be secondary school credits, with each credit intended to be comprised of 110-120 hours of study. It is left to the schools to adjust their preferred emphases within the course objectives so that unique needs may be met using this guide.

INTEGRATION OF TOPICS

Whereas this curriculum guide provides a suggested sequence of modules and topics within modules, it is recommended that the implementation of the courses be based upon continued integration and revision of the following topics:

- safety,
- career exploration,
- consumerism,
- applied mathematics,
- communication skills.

Teachers are expected to integrate topics as suited to their unique preferences, emphases, laboratory requirements, student needs and sequencing of topics within the course.

In some instances it may be the choice of a teacher to provide a THEME around which the course will be implemented. The following themes are commonly integrated in Industrial Arts programs:

1. Process Orientation - a theme which emphasizes the systematic use of materials;

2. Product, or Project Orientation - a theme which focusses on the net result of skills development;

3. Design Orientation - a theme which develops the creative problem-solving, and decision-making processes in a generic sense;

4. Tools and Materials Orientation - a theme which focusses on the equipment and supplies used in that particular area of Industrial Arts.

MATERIALS

Supplemental material, both for student and teacher reference, is referred to throughout the guide. More detailed bibliographic data is provided in an appendix to this guide.

SPECIAL NEEDS STUDENTS

Industrial Arts 101, 201, 301 is designed as an option program for ALL STUDENTS in the secondary school. Many pupils headed for the technical areas of colleges and universities benefit from secondary exposure to the areas of design, engineering, electronics, and the trades. Industrial Arts serves the special needs of the university student.

The special needs of the greatest number of secondary students would include the exploratory and generic skills development emphasized in Industrial Arts. There is a strong linkage between the practical arts and life-long avocational skills necessary to everyday life.

Industrial Arts can provide some motivational value for students who enroll in these courses because they offer "alternative" credits to other less pragmatic options. The "hands-on" nature of Industrial Arts provides a multifaceted dimension to learning. The many senses involved in practical arts offer students a greater chance to experience success in their particular learning modes. While Industrial Arts is NOT DESIGNED TO BE AN AREA OF STUDY FOR THE LEARNING IMPAIRED, it CAN accommodate students in unique ways.

Many innovative programs for the physically handicapped have been developed with safety precautions being taken into account. The use of jigs and fixtures for specific handicaps has offered new successes to such students. Tailoring Industrial Arts to the handicapped requires not only a careful scrutiny of hazards, safety requirements, methodologies, and special supports (fixtures, jig aids), but also the recognition necessary from administrators and colleagues.

EVALUATION

Industrial Arts involves both theoretical and practical learning. Teachers are expected to conduct student evaluations in accordance with their predetermined course planning (syllabus); the special theme or orientation used in the implementation; the specific objectives set for each student (special needs taken into account); and the standards of performance agreed upon at the outset. These are VALIDITY issues which will reflect the appropriateness of grades issued.

Generally, teachers agree upon this range of criteria. However, each teacher must provide a unique WEIGHTING to validate his/her choice of the program variables to be implemented.

goals and objectives

PROGRAM GOALS

The general goals of the senior high school Industrial Arts programs include the following:

1. To develop creative potential in both vocational and avocational life;
2. To promote an awareness of the role played by technology in the modern world;
3. To assist in the selection of a career choice and career plan;
4. To promote the development of basic and generic skills in the use of common industrial tools and machines, and in the implementation of processes;
5. To develop a learning environment and attitude that fosters achievement in a practical manner;
6. To enable students to discover and develop talents, aptitudes and interests;
7. To promote the development of problem-solving skills;
8. To enhance the student's self understanding;
9. To develop teamwork attitudes and skills;
10. To enable the student to acquire an appreciation for decision-making and problem-solving techniques.

OBJECTIVES

The following listing includes all of the objectives cited in the Level II section of this guide. While the implementation of the objectives is required for both the CORE and OPTIONAL modules, it is left to the individual teachers to assess whether certain objectives will be integrated generally or taught individually.

Emphasis and sequencing are also left to the teachers' judgment, based on personal preferences, assessment of student needs and preferences, the nature of facilities, and/or the particular theme around which the course is delivered (process, product, design, or tools orientation).

Metalwork 101, 201, 301:

1. Student Orientation and Safety

The student should be able to:

- define Industrial Arts;
- develop an understanding of the vocational and avocational activities in Industrial Arts;
- trace the historical development of metalwork;
- summarize the general outline of the Metalwork 101 course;
- outline the method of evaluation to be used in this course;
- recognize the relationship between junior and senior high metalwork;
- identify and use reference materials;
- locate information about occupations related to metalwork;
- understand the need for safety and safety equipment;
- understand safety standards and apply them to metalwork;

- describe the procedures to be followed in the metalworking lab;
- accept responsibility for developing safety habits;
- list hazardous conditions in the metal lab;
- identify emergency procedures;
- understand the use of fire extinguishers;
- understand accident reporting procedures;
- outline the need for safe clothing in metal working labs;
- identify and accept responsibility for housekeeping practices.

2. Product Planning

The student should be able to:

- recognize the importance of design to metalwork;
- describe basic elements of design;
- identify the principles of design;
- understand design factors;
- apply the principles of design to the design process;
- understand the importance of technical drawing;
- understand the basic types of technical drawing;
- understand the components of a technical drawing;
- produce a technical drawing;
- read a blueprint;
- sketch a product;
- explain the need for a bill of material;
- complete a bill of material;
- solve mathematical problems related to the planning and production of a product.

3. Measurement and Use of Instruments

The student should be able to:

- define measurement;
- explain the need for measurement;
- recognize the need for standards;
- understand the concepts of Imperial (Canadian) and SI metric linear measurement;
- apply linear measurement concepts;
- identify measuring devices;
- explain the purpose of the various measuring devices;
- identify gauges used in metalworking;
- explain the purpose of each metal gauge;
- identify care procedures for all types of measuring tools and instruments;
- read different types of rules;
- read a micrometer;
- read a caliper;
- read a dial indicator;
- identify technological developments in measuring instruments.

4. Basic Machine Tool Technology

The student should be able to:

- identify basic metal-machining processes;
- list common metal-working machines related to machining processes;
- develop an understanding and determine the correct procedural sequence of machining operations;

- list the safety hazards pertaining to the drill press;
- explain the purpose for securing stock when drilling;
- explain how to secure stock for the purpose of drilling;
- select the proper speed and feed for the material being drilled;
- list types of lubricants used when drilling;
- select the proper type and size of twist drill for the purpose of drilling;
- perform operations safely on a drill press;
- identify the safety precautions involved when using the grinder;
- identify the components of grinding wheels;
- explain why all grinding wheels have an RPM limit;
- understand dressing and truing a wheel;
- identify the factors to consider when selecting a grinding wheel;
- perform grinding operations safely;
- identify safety precautions involved when using a metal lathe;
- identify the major parts of the lathe and describe the functions of each;
- explain lathe size;
- select the proper type of cutting tool;
- identify and select the proper type of tool bit holder;
- select the proper cutting speed, feed rate and depth of cut for the machining operation;
- face round stock using a universal chuck;
- drill center holes in a workpiece mounted in a universal chuck;
- check lathe center alignments;
- properly center a cutting tool on the lathe;
- mount and turn work between centers;

- mount and turn work in a lathe chuck;
- set up lathe for rough turning;
- set up lathe for finish turning;
- cut tapers with the compound rest;
- set up stock for drilling in a lathe chuck;
- set up stock for knurling;
- cut off stock with a parting tool;
- perform the proper procedure for finishing work on the lathe;
- apply skills of measurement as required in lathe work;
- grind a tool bit for lathe turning;
- describe the principle of milling;
- identify the types of milling machines;
- identify various operations performed by milling machines;
- understand safety practices involved with milling machines;
- identify the basic mill cutters;
- understand mill cutting speeds;
- set up stock in the milling machine;
- set proper mill cutting speeds;
- identify the proper lubricant for milling operations;
- mill flat surfaces on the milling machine;
- describe the principle of shaping;
- describe the application of the shaping principle to the shaper, planer and slotter;
- identify safety precautions involved when using the shaper;
- identify the major parts of the shaper and describe the functions of each;
- mount work piece in the table vise;
- select the proper cutting tool;
- set the tool head;
- set the stroke length;
- set the table clearance underarm;

- adjust ram position;
- set table feed;
- perform shaping operations;
- become familiar with careers related to machining metals.

5. Basic Arc Welding

The student should be able to:

- recognize and develop an understanding of safe arc welding procedures in the metal lab;
- identify arc welding safety equipment;
- identify hand and power tools related to arc welding;
- understand the principle of arc welding;
- identify arc welding equipment and accessories;
- understand basic arc welding terms;
- describe and recognize arc welding positions;
- identify basic arc welding joints;
- list the group classification of electrodes;
- understand electrode number classification;
- select the proper arc welding electrode;
- identify the basic principles of sustaining a welding arc;
- develop the ability to strike an arc;
- explain the procedure for making stringer beads;
- run a series of beads;
- explain the procedure for weaving;
- identify and explain arc welding defects;
- weld basic joints in the flat position;
- explain resistance welding;
- understand the applications of resistance welding;
- describe the operations of spot welding;
- weld metal using a spot welder;
- be familiar with the careers related to arc welding.

6. Basic Oxy-Acetylene Welding

The student should be able to:

- identify the safety aspects pertaining to oxy-acetylene welding;
- list oxy-acetylene welding equipment;
- understand the purpose of oxygen in oxy-acetylene welding;
- understand the purpose of acetylene to oxy-acetylene welding;
- identify and describe the oxy-acetylene cylinders;
- identify the welding torch;
- identify care procedures in handling a welding torch;
- identify the common sizes of welding tips;
- identify types of regulators;
- describe the purpose of regulators;
- identify the oxy-acetylene hoses;
- identify uses of oxy-acetylene equipment;
- describe set-up procedures for oxy-acetylene welding;
- describe the starting-up procedure for oxy-acetylene welding;
- light the oxy-acetylene torch;
- identify the oxy-acetylene welding flames;
- demonstrate proper flame control;
- recognize and identify backfire and flashback;
- describe the procedure for shutting off the oxy-acetylene system;
- demonstrate the proper procedure for shutting off the oxy-acetylene torch;
- list types of metals that could be welded by

the oxy-acetylene process;
- understand the melting points of common metals;
- select and prepare metal material for welding;
- apply the safety procedures to oxy-acetylene welding;
- define cohesion;
- demonstrate the ability to puddle;
- demonstrate the ability to run a bead;
- identify the basic weld joints;
- weld basic joints;
- define adhesion;
- define brazing;
- identify advantages and disadvantages of brazing;
- describe the purpose of flux;
- identify the types of brazing flux;
- describe the characteristics of filler metals;
- prepare a metal for brazing;
- use the brazing process to join metals;
- explain the difference between soft and hard soldering;
- identify fluxes used for soldering;
- describe the composition and characteristic of solder;
- use the flame soldering process to join metal;
- identify the oxy-acetylene cutting equipment;
- describe the procedure for using the cutting torch;
- set up the cutting torch;
- perform oxy-acetylene cutting procedures;
- be familiar with careers in oxy-acetylene welding.

7. Sheet Metal

The student should be able to:

- identify the common types of sheet metal;
- describe how sheet metal is manufactured;
- identify common sheet metal products;
- identify standard sheet metal sizes;
- demonstrate safe handling of sheet metal;
- identify the methods of pattern development;
- describe the use of each method of pattern development;
- produce patterns by using two different development methods;
- identify layout tools for sheet metal work;
- describe techniques of sheet metal layout;
- demonstrate proper techniques of sheet metal layout;
- identify sheet metal separating tools and equipment;
- explain the use of sheet metal separating tools and equipment;
- demonstrate proper techniques in separating sheet metal;
- identify sheet metal forming tools;
- explain the purpose of various forming tools and equipment;
- demonstrate proper techniques in the use of sheet metal forming tools and equipment;
- identify methods of fastening sheet metal;
- select suitable methods of fastening sheet metals;
- demonstrate proper techniques of fastening sheet metal;
- surface-coat metal with organic/inorganic finishes;
- apply a physical finish to sheet metal;
- apply a chemical finish to sheet metal;
- identify careers related to sheet-metal work.

8. Bench Metal

- identify common types of metals used for bench-metal work;
- list common metal shapes and sizes used for bench-metal work;

- identify layout tools for bench-metal work;
- describe the purpose of various layout tools;
- apply proper techniques in the use of layout tools;
- identify separating tools for bench-metal work;
- describe the purpose of various bench-metal separating tools;
- apply proper techniques in the use of separating tools;
- identify tools for forming bench-metal;
- describe the purpose of various bench metal forming tools;
- apply safe procedures in forming bench metal;
- identify methods of fastening bench metal;
- identify common screw thread series;
- select appropriate tools for producing internal and external threads;
- perform basic hand threading operations using taps and dies;
- identify tools for reaming techniques.
- demonstrate appropriate procedures to fastening bench metal;
- identify methods to finishing bench metal;
- demonstrate finishing techniques;
- identify careers related to bench-metal work.

9. Foundry Practice

The student should be able to:

- identify casting procedures;
- describe casting procedures;
- develop an awareness of safety precautions in the casting process;
- identify common tools and equipment related to the sand casting process;
- identify factors of good foundry sand;
- identify metals used for casting;
- identify patterns used for sand casting;
- make a mold using a simple pattern;
- make a mold using a split pattern;
- prepare metal for melting;
- pour metal into mold;
- remove the casting from the mold;
- identify technological developments in metal casting;
- identify common methods for finishing castings;
- finish the metal casting;
- be familiar with careers related to foundry manufacturing;
- make a simple pattern for casting;
- make a split pattern for casting.

10. Forging Practice

The student should be able to:

- define hand forging;
- identify the advantages of forging metal;
- identify the safety aspects pertaining to metal forging;
- list the tools and equipment used for hand forging;
- light the equipment used for forging;
- draw-out metal by forging;
- taper metal by forging;
- bend metal by forging;
- twist metal by forging;
- upset metal by forging;
- finish forged metal;
- heat-treat metal formed by forging;
- describe the industrial applications of forging;

. be familiar with occupations related to forging.

11. Metallurgy and Basic Heat Treatment

The student should be able to:

. define metallurgy;
. understand the classification of metals;
. list the properties of metals;
. describe the physical properties of metals;
. describe the mechanical properties of metals;
. define ferrous and non-ferrous metals;
. identify common types of metals;
. identify metal-coding systems;
. describe how steel is manufactured;
. understand how most steel is shaped;
. define heat treatment;
. describe the properties of steel that can be changed by heat treatment;
. list the principal kinds of heat treatment processes;
. identify heat treatment furnaces;
. define annealing;
. describe the procedure for full annealing;
. perform operations safely in annealing metal material;
. define hardening;
. describe the procedure for hardening carbon tool steel;
. perform operations safely in hardening carbon tool steel;
. define tempering;
. explain the tempering process;
. perform operations safely in tempering carbon tool steel;
. define normalizing;
. describe the procedure in normalizing carbon steel;
. perform operations safely in normalizing carbon steel;
. define case hardening;
. describe the case-hardening process;
. perform safely case-hardening procedures;
. explain the flame-hardening process and its use;
. explain the induction-hardening process and its use;
. explain the laser and electron beam-hardening process;
. define powder metallurgy;
. list the main types of powder-metal materials;
. identify advantages of the powder-metal process;
. identify uses of powder-metal parts.

12. Art Metal

The student should be able to:

. identify tools used in working with art metal;
. identify metals used for art metal;
. identify methods of surface decoration;
. anneal different types of metal used for art work;
. draw and transfer designs on metal;
. engrave a design on metal;
. describe metal etching;
. etch various metals;
. clean metal by pickling;
. enamel copper and other types of non-ferrous metals;
. solder different types of non-ferrous metals;
. select cutting compounds for buffing wheels;
. buff metal on a buffing wheel;
. finish metal surfaces.

13. Advanced Welding

The student should be able to:

- recognize the safety aspects pertaining to oxy-acetylene welding;
- review basic oxy-acetylene welding;
- weld basic joints in the vertical position;
- weld basic joints in the overhead position;
- weld heavy plate in the vertical position;
- cut heavy plate using a cutting torch;
- perform silver-soldering techniques;
- recognize the safety aspects pertaining to arc welding;
- review basic arc welding;
- arc weld basic joints in the vertical position;
- arc weld basic joints in the overhead position;
- weld a multiple-pass weld in the vertical position;
- weld a multiple-pass weld in the overhead position;
- review arc welding defects;
- define hard-surfacing;
- prepare metal for hard-surfacing;
- apply hard-surfacing to mild steel;
- understand how metal alloys may be arc welded;
- explain MIG welding;
- list advantages of MIG welding;
- identify MIG welding equipment;
- display a knowledge of the wire-feeding mechanism;
- understand the purpose of the shielded gas used in MIG welding;
- prepare basic metal joints for MIG welding;
- select proper welding current for welding;
- MIG weld basic joints;
- identify MIG welding defects;
- explain TIG welding;
- understand basic terminology applied to the gas tungsten arc process;
- identify tungsten arc equipment;
- describe electron beam welding;
- describe inertia welding;
- describe laser welding;
- describe plasma welding;
- describe ultrasonic welding;
- explain the arc electrode cutting method;
- describe the powder cutting method;
- describe the plasma cutting method;
- understand air carbon arc cutting method.

14. Advanced Machine Tool

The student should be able to:

- understand safety in respect to various machine-tool operations;
- define countersinking, counterboring, reaming, and tapping;
- identify tools for counterboring, countersinking, reaming, and tapping;
- identify industrial applications of the drilling process;
- understand the principles and procedures of off-hand drill grinding;
- identify industrial applications of the grinding process;
- identify different types of hand-held grinders;
- perform operations safely using hand-held grinders;
- understand abrasive cut-off operations;
- perform operations safely using abrasive cut-off machines;
- mount and test grinding wheels;
- identify the shapes of lathe-cutting tools;
- grind a lathe toolbit for roughing mild steel;

- grind a lathe toolbit for finishing mild steel;
- sharpen lathe-cutting tools;
- identify the different types of lathe chucks;
- mount and remove different types of lathe chucks;
- mount stock in a four-jaw chuck;
- calculate cutting speeds for basic ferrous and non-ferrous metals;
- turn metal stock to a shoulder;
- use a parting tool;
- cut tapers using the offset tailstock method;
- cut tapers using a taper attachment;
- cut tapers using the compound rest;
- describe thread forms;
- perform thread cutting operations on the lathe;
- define boring;
- perform boring as an operation on the lathe;
- mill a slot or keyway on the milling machine;
- machine a block square and parallel;
- perform drilling operations on the milling machine;
- understand the purpose and use of the dividing head;
- understand the procedure for cutter and milling machine maintenance;
- identify industrial applications of the shaping process.

15. Modern Industry

The student should be able to:

- define enterprise system;
- understand the various systems of business organization;
- identify the five divisions of an industrial organization;
- explain the responsibilities of each of the divisions of an industrial organization;
- explain the components of the management cycle;
- describe the basic M's of a manufacturing corporation;
- explain the procedures for incorporating a company;
- organize an in-school company to manufacture a product;
- define mass production;
- identify the fundamental principles of mass production;
- describe the influence of mass production on society;
- identify the basic production resources for industry;
- describe the basic steps requisite for planning a manufacturing mass-production system;
- understand the principles of jig and fixture design;
- produce a product by applying the principles of mass production;
- understand the history of robotics;
- define a robot;
- differentiate among industrial, training, and personal robots;
- understand robot-classification systems;
- explore the socio-economic factors of robotics;
- understand the basic drive systems used to operate a typical industrial robot;
- understand the mechanisms which impact and control robot motion;
- understand the factors used in planning a robot installation;
- identify the safety aspects surrounding the robot and how it affects robots and humans;
- identify potential careers in the area of robotics;
- develop a list of advanced processes in the metalwork industry;
- present a technical report.

metalwork 101, 201, 301

METALWORK 101, 201, 301

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STUDENT ORIENTATION AND SAFETY ME-01

Major Objective: To have an opportunity to evaluate personal goals and needs in today's industrial society, and to develop safety consciousness and practices in the use of tools, machines, and materials.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. STUDENT ORIENTATION The student should be able to:		
1. Define Industrial Arts.	Discuss the meaning and value of the study of Industrial Arts Metalwork and how the products of today's technology are dependent upon parts made of metal.	Industrial Arts A phase of general education which serves to familiarize students with the tools, products, and processes of industry as well as with the social and economic phenomena of the technological world in which we live and work.
2. Develop an understanding of the vocational and avocational activities in Industrial Arts.	Discuss the role of Industrial Arts in the general education of students. Relate the discussion to the definition of Industrial Arts and the program goals common to all levels of Industrial Arts. Discuss vocational and avocational pursuits.	Avocation An activity pursued in addition to regular work; done for enjoyment. Vocation A person's occupation to gain a livelihood.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Trace the historical development of metalwork.	Explain to the students some aspects of the history of metalwork by indicating the development of materials and processes, and the impact of the Industrial Revolution.	
4. Summarize the general outline of the Metalwork 101 course.	Prepare transparencies, charts and/or handouts to provide students with information about the modules in 101 Metalworking.	
5. Outline the method of evaluation to be used in this course.	Explain course requirements and methods of record keeping including the system of evaluation, e.g., projects, quizzes, exams, attendance, notebooks, etc. Have students prepare and maintain a notebook as an ongoing project. Encourage students to include the following in their notebook: notes, sketches, illustrations, handouts, instruction sheets, and articles from technical periodicals and newspapers.	
6. Recognize the relationship between junior and senior high metalwork.	Explain the difference between the programs and highlight common major goals which lead towards completion of the high school program.	Industrial Arts 7-9: Manufacturing, Manitoba Education

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
7. Identify and use reference materials.	Explain the use and availability of reference materials in your school lab and library. Provide students with opportunities to use reference materials for problem solving, technical research, and report writing.	
8. Locate information into occupations related to metalwork.	Obtain literature to develop a storehouse of materials on careers and occupations pertaining to metalwork. Make the students aware of the importance of the following technical foundations to metalworking: mathematics, reading drawings, using handbooks, shop safety, terminology and procedures.	Career Awareness Resource Library (video recordings), Manitoba Education Library Sheet Metal Working (kit), Manitoba Education Library

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. SAFETY The student should be able to:		
1. Understand the need for safety and safety equipment.	Discuss the contribution of safety knowledge, skills, and positive attitudes to safe living and working at home, in schools and in communities. Demonstrate and practice proper procedures and techniques for safe handling of tools, materials, and equipment.	Safety Equipment 1. Guards 2. Face Shields 3. Goggles 4. Gloves 5. Aprons 6. Fire Blankets 7. Fire Extinguisher 8. Leggings 9. Helmet 10. First Aid Kit
2. Understand safety standards and apply them to metalwork.	Indicate to the students the problems that can occur within the metal shop and point out the need for good behaviour as well as safety in respect to tools, equipment, facilities, and materials.	On Guard, (colour filmstrip, cassette, program guide), Prentice Hall If I Had a Hammer (16mm colour film), Manitoba Education Tips For New Employees (slides), available from Workplace Safety and Health Division, Department of Environment

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Describe procedures to be followed in the metalworking lab.	Discuss and have the students analyze the procedures requisite for increasing efficiency and safety. Explain the importance of and insist upon student participation in daily laboratory cleanup.	The Workplace Safety and Health Act, Manitoba Statutes, Queen's Printer Safety Attitudes (slides), available from Workplace Safety and Health Division, Department of Environment
4. Accept responsibility for developing safety habits.	Discuss the importance of behaviour in relation to safe practices. Develop a set of rules for behavior, making students aware of the reasons and that each has a responsibility not only for personal but also for group safety.	Everything to Lose, The Split Second, (16mm colour films), available from Workplace Safety and Health Division, Department of Environment Occupational Health and Safety: A Training Manual, Copp Clark Pitman It's Happened Before (16mm colour film), Manitoba Hydro
5. List hazardous conditions in the metal lab.	Indicate to the students the potential hazard areas of the shop and how accidents can be avoided.	Hazardous Conditions 1. Hot metal 2. Chips 3. Ultraviolet and infrared rays 4. Fumes 5. Sharp metal 6. Oils, grease 7. Compressed air 8. Chemicals

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Identify emergency procedures.	Make students aware of emergency procedures related to first aid, fire, and accidents. Point out the location and discuss the use of emergency shut-off switches.	
7. Understand the use of fire extinguishers.	Discuss the different types of fire extinguishers and their limitations. Point out to students where they are located within your shop and how to use them should an emergency arise.	The A,B,C's and D's of Portable Fire Extinguishers (16mm colour film), Film Library, Manitoba Hydro
8. Understand accident-reporting procedures.	Explain the reason and importance of reporting all accidents, no matter how trival. Explain reporting procedures and the purpose of accident-report forms. Record health problems students might have.	School Policy Manual
9. Outline the need for safe clothing in metal working labs.	Discuss the relationship of clothing and other protective devices to work being done. Point out the hazards associated with loose clothing, long sleeves, jewellery, etc.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
10. Identify and accept responsibility for housekeeping practices.	Point out that good housekeeping practices aid in providing a pleasant, safe, and well-organized environment for work and learning.	Housekeeping Means Safekeeping (16mm colour film) and Keep It Clean for Safety's Sake, Workplace Safety and Health Division, Department of Environment

PRODUCT PLANNING ME-02

Major Objective: To acquire knowledge and skill of the principles and procedures of design and to apply this knowledge and skill to planning of a metal product.

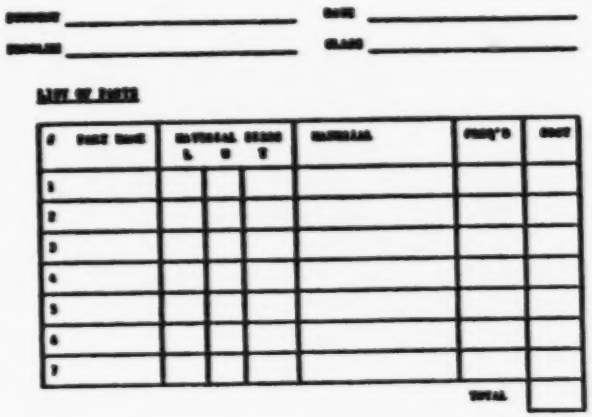
OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. DESIGN REQUIREMENTS The student should be able to:		
1. Recognize the importance of design to metalwork.	Describe the design process from defining the problem to implementing the design. Have the students follow the design process.	Importance of Design 1. Product efficiency 2. Visual impact 3. Practicality
2. Describe basic elements of design.	Outline the major elements of design showing how they are related to product engineering.	Elements of Design 1. Line 2. Shape 3. Space 4. Colour 5. Texture
3. Identify the principles of design.	Have students collect illustrations and models of various types and styles of metalwork. Ask them to examine and assess the illustrations and models by answering these questions about the application of the design principles: a) Balance -- Do the parts seem to have the same mass or value? Are the parts on each side of the centre line alike in size and shape?	Principles of Design 1. Balance 2. Proportion 3. Harmony 4. Rhythm 5. Emphasis

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	b) Proportion -- Does the size of one part of a product relate to another part? How does the function or use of an object control its proportion? c) Harmony and Unity -- Do the parts of an object appear to belong together? d) Rhythm -- Are the elements or features such as lines, curves, forms, colours, and textures repeated? Do they give the object a pleasing appearance? e) Emphasis --- Does the design have a point of interest?	
4. Understand design factors.	Provide examples pointing out good and poor design factors.	Design Factors 1. Appearance 2. Function 3. Material 4. Cost 5. Workmanship
5. Apply the principles of design to the design process.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. TECHNICAL DRAWING **The student should be able to:**		
1. Understand the importance of technical drawing.	Explain to the students the importance of technical drawing and how it relates to the production of a metal product in your lab.	Basic Blueprint Reading and Sketching, Delmar Publishing
2. Understand the basic types of technical drawing.	Point out that pictorial drawings represent the shape with just one view and are frequently used for illustrative purposes, whereas an orthographic projection uses two or three views to describe the shapes of objects completely and exactly.	Types of Technical Drawing 1. Orthographic 2. Pictorial - isometric - oblique
3. Understand the components of a technical drawing.	Explain to the students the major components of a technical drawing. Provide students with an information sheet and have them locate technical drawing components.	Components of A Technical Drawing 1. Lines 2. Symbols 3. Dimensions 4. Abbreviations
4. Produce a technical drawing.	Have the students do a simple exercise in basic technical drawing placing emphasis on orthographic and isometric drawing.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Read a blueprint.	Obtain blueprints related to your subject matter and have students identify and explain the symbols used on working drawings.	
C. PROCEDURE AND LAYOUT The student should be able to:		
1. Sketch a product.	Have the students do a basic exercise in sketching and explain the purpose for such an exercise in regard to product planning.	
2. Explain the need for a bill of material.	Explain to the students the need and the purpose for a bill of materials. Have the students list each part of a sample product and prepare a bill of material.	Bill of Material 1. Parts of the product 2. Number of pieces 3. Size of stock 4. Shape and kind of material 5. Unit cost of material 6. Total cost

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Complete a bill of material.	Have students complete worksheets identifying a material listing of their product designs, e.g.:	
4. Solve mathematical problems related to the planning and production of a product.	Prepare basic mathematical problem exercises for the students to work on individually. These should include fractions, decimals, weight, volume, costs, formulas, etc., as related to the modules in this course.	



MEASUREMENT AND USE OF INSTRUMENTS ME-03

Major Objective: To develop knowledge and skill related to Imperial (Canadian) and SI metric systems of measurement and measuring instruments and to apply measurement to activities and problems pertinent to metalwork.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. MEASUREMENT CONCEPTS The student should be able to: 1. Define <u>measurement</u>.	Integrate, where applicable, instruction, practice, and applications of measurement throughout appropriate modules. Have students discuss and define measurement. Emphasize that measurement is a method used to communicate information about size, shape, distance, and weight, and have students give examples of metalwork measurements related to these.	<u>Measurement</u> A method of communicating size, shape, distance, and weight. <u>Basic Types of Quantity Measurement</u> 1. Length 2. Mass 3. Time 4. Temperature 5. Electric current 6. Amount of a substance 7. Light intensity <u>Metric System Metric Units</u> (colour transparency series, overlays, instructor's guide), AIM Educational Aids

UNITS OF MEASURE

QUANTITIES	SI METRIC UNITS	IMPERIAL UNITS	APPLICATIONS
Length, distance	metre	yard foot, inch	Linear measurements Thickness, width, and length of metal materials
	millimetre	foot, inch	Length and width of metal products and buildings
			Layout work and measurements in respect to constructing parts of metal products
Area	square millimetre, square centimetre, square metre	square inch, square foot, square yard	Area of parts of metal products and metal buildings
Volume	cubic millimetre, cubic centimetre, cubic metre	cubic inch, cubic foot, cubic yard	Volumes of various types of metal stock
Mass/ Weight	kilogram	pound	Quantity unit of metal stock
Temperature	degrees Celsius	degrees Fahrenheit	Heat treating of metals
Pressure	kPa MPa	p.s.i.	Pressure and stress related to metals

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Explain the need for measurement.	Make students aware of the relationship between good work quality and accurate measurements.	
3. Recognize the need for standards.	Explain that standards of measurement have been agreed upon by organizations such as ISO, ANSI, and CSA, and that the same standards throughout the world aid in communicating information.	ISO International Organization for Standardization ANSI American National Standards Association CSA Canadian Standards Association Standard Measurement (colour, 16mm film), Library, Manitoba Education
4. Understand the concepts of Imperial (Canadian) and SI metric linear measurement.	Explain the difference between Imperial (Canadian) and SI metric measurement. Have the students do exercises in measuring linear measurements and diameters using special instruments. Place emphasis on the SI system.	SI Metric Guide, Technical Education, Province of Manitoba, Department of Education, 1979
5. Apply linear measurement concepts.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. MEASUREMENT INSTRUMENTS The student should be able to:		
1. Identify measuring devices.	Demonstrate the use of the various measuring devices available in your metal-working lab.	Measuring Devices 1. Rules -pocket -flexible -hook -circumference 2. Micrometer 3. Calipers 4. Dividers 5. Dial indicators 6. Combination squares
2. Explain the purpose of the various measuring devices.	Have the students discuss the purpose of the various measuring devices and their appropriate uses.	
3. Identify gauges used in metalworking.	Demonstrate the use of the various metal gauges that are available in your metal-working lab.	Metal Gauges 1. Wire and sheet metal gauges 2. Drill gauges 3. Thread gauges 4. Surface gauges 5. Telescopic gauges 6. Feeler gauges 7. Hole gauges

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Explain the purpose of each metal gauge.	Have the students discuss the purpose of the various metal gauges and their appropriate uses.	
5. Identify care procedures for all types of measuring tools and instruments.	Explain to the students the purpose and need for proper care and maintenance of all types of measuring tools and instruments.	
6. Read different types of rules.	Point out to the students the different types of rules and explain how to use them.	
7. Read a micrometer.	Have the students do exercises on reading the micrometer. Use charts, mock ups, etc., to acquaint students with reading a micrometer.	
8. Read a caliper.	Demonstrate the use of the inside and outside calipers. Have the students practice using the calipers, with emphasis on accuracy.	
9. Read a dial indicator.	Demonstrate to the students how to read a dial indicator. Obtain diagrams of a dial indicator and present it as a group exercise.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
10. Identify technological developments in measuring instruments.	Have students research current industrial measurement applications, e.g., laser light, optical, etc.	

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BASIC MACHINE TOOL TECHNOLOGY ME-04

Major Objective: To acquire knowledge and skills related to a number of machining processes in metalwork and be able to perform these processes using tools and equipment available in the metal lab.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. METAL WORKING MACHINES The student should be able to:		
1. Identify basic metal-machining processes.	Explain to students that machining is one of the four major metal-manufacturing methods (the others are hot forming, cold working, and casting). In machining, metal is turned, shaped, milled, cut, or otherwise reduced or changed by removing chips with machine tools to produce the shape and dimension wanted. Describe to the students what basic machining may involve and indicate the type of equipment that is used in this metal-working module.	Machining Processes 1. Drilling 2. Grinding 3. Turning 4. Milling 5. Shaping (Planing)
2. List common metal-working machines related to machining processes.	Discuss these machining processes: a) Drilling is using a rotating cutter to cut cylindrical holes in the workpiece. b) Grinding is removing excess material from a workpiece by using rotating abrasive wheels. c) Turning is cutting stock as it revolves in a lathe. d) Milling is shaping a workpiece by using a rotating cutting tool that has two or more cutting edges. e) Shaping (Planing) is shaping metal by making straight line back and forth cuts.	Metal Working Machines 1. Drill press 2. Grinder 3. Lathe 4. Milling machine 5. Shaper

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. MACHINING SEQUENCE The student should be able to: 1. Develop an understanding and determine the correct procedural sequence of machining operations.	Emphasize that it's a good idea to "plan your work, and then work your plan". Point out that waste of time, effort, and materials could very often be avoided if a planned order of operations were carefully prepared. In industry, the engineer includes an order of operations when making up shop orders and work orders, for machining, assembling, inspecting, etc. Have students identify a list of steps needed to complete a project or job.	

STEP	OPERATION	MACHINE OR TOOL REQ'D
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
C. THE DRILL PRESS The student should be able to:		
1. List the safety hazards pertaining to the drill press.	The drill press is one of the most common types of machines used in a metal shop. It also is one on which many accidents occur. Explain and demonstrate to the students proper drill press safety.	Drill Press Safety 1. Remove or tuck in loose clothing. 2. Wear eye protection. 3. Secure work solidly. 4. Always remove key from the chuck. 5. Allow machine to stop on its own. 6. Clean chips from work with a table brush. 7. Clean work area after completion of work.
2. Explain the purpose of securing stock when drilling.	There are many methods used to secure stock for the purpose of drilling. Select the most appropriate for your individual needs.	
3. Explain how to secure stock for the purpose of drilling.	Demonstrate the use of the various holding devices in the metalworking lab.	Holding Devices 1. Vises 2. V-blocks 3. T-bolts 4. Clamps 5. Pliers 6. Vise grips 7. Monkey wrench

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Select the proper speed and feed for the material being drilled.	By using charts and overlays, explain the need for proper drill speed and proper drill feed for drilling into various types of metal. Discuss factors such as: a) the kind of material being drilled; b) the cutting tool material; c) the quality of hole desired; d) the way in which the work is set up or held; e) the size of the bit; f) the size and type of drilling machine; g) the use of cutting fluid.	
5. List types of lubricants used when drilling.	Point out different types of metal lubricants used for drilling. Explain the purpose of using lubricants and have students select an appropriate one for their purpose.	Types of Lubricants 1. Petroleum oil 2. Lard oil 3. Mineral oil 4. Soap and water 5. Kerosene
6. Select the proper type and size of twist drill for the purpose of drilling.	Explain how to select the proper types of twist drills for drilling. Review the factors discussed in speed and feed of drilling into metal material.	
7. Perform operations safely on a drill press.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
D. THE GRINDER The student should be able to:		
1. Identify the safety precautions involved when using the grinder.	Prepare a list of grinder safety rules that should be followed for grinding. Emphasize that in any operation involving abrasives, safety glasses or goggles must be worn.	
2. Identify the components of grinding wheels.	Demonstrate and describe different kinds and grades of grinding wheels. Point out that the right grinding wheel for a job is one that has: a) the correct coarseness of abrasive grains; b) abrasive grains spaced far enough apart to remove the right amount and kind of chips and to keep the wheel from clogging; c) the proper bond to produce the desired smoothness of finish.	Composition of Grinding Wheels 1. Type of abrasive 2. Grain size 3. Grade 4. Bond 5. Structure
3. Explain why all grinding wheels have an RPM limit.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Understand dressing and truing a wheel.	Discuss the purpose for dressing and truing grinding wheels. Using a wheel dresser, demonstrate how to dress and true a grinding wheel.	Dressing Sharpening a wheel. Truing Cutting the wheel so there will be no high spots when the wheel is running.
5. Identify the factors to consider when selecting a grinding wheel.	Point out that grinding wheels are made in nine standard shapes and twelve standard faces and are used to do all kinds of grinding on all types of grinding machines. Demonstrate the "ring" test before installing a grinding wheel.	Factors 1. The material to be ground and its hardware 2. The amount of stock to be removed and the finish required 3. Whether the grinding is done wet or dry 4. The wheel speed 5. The area of grinding contact 6. The severity of the grinding operation 7. The horsepower of the machine
6. Perform grinding operations safely.	Demonstrate to your students the proper techniques in using the grinding wheel as well as how to use holding devices on small pieces of metal. NOTE: NEVER GRIND ON THE SIDE OF A GRIND STONE.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
E. THE METAL LATHE The student should be able to:		
1. Identify safety precautions involved when using a metal lathe.	Discuss and have students prepare a list of safety precautions.	
2. Identify the major parts of the lathe and describe the function of each.	List the major parts of the lathe and explain to your students the basic function of each. Follow the discussion of theory with demonstration.	Principal Parts of a Lathe 1. Bed 2. Headstock assembly 3. Tailstock assembly 4. Feeding and threading mechanism 5. Work holding attachments 6. Other accessories
3. Explain lathe size.	With the aid of charts, transparencies, filmstrips, etc., have students prepare a labelled diagram of the lathe. Point out that lathe size is indicated by swing and the length of the bed.	
4. Select the proper type of cutting tool.	There are four common shapes of cutting tools. They are ground for left-hand and right-hand applications.	Cutting Tool Shapes 1. Facing 2. Roughing 3. Finishing 4. Round nose

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Identify and select the proper type of tool bit holder.	Describe to the students the various types of tool bit holders used for turning. Explain how each should be selected.	Tool Bit Holders 1. Straight 2. Left hand 3. Right hand
6. Select the proper cutting speed, feed rate, and depth of cut for the machining operation.	Explain how the selections of cutting speed, feed rate, and depth of cut are applied to basic machining operations.	Cutting Speed The speed at which the circumference of the work passes the tool bit. This is expressed in feet per minute (fpm) or meters per minute (mpm). Feed Rate The distance the cutting tool moves in one revolution of the workpiece. Depth of Cut The distance the tool is advanced into the work at a right angle to the work.
7. Face round stock using a universal chuck. 8. Drill center holes in a workpiece mounted in a universal chuck.	Demonstrate how to set up stock in a universal chuck and show the students the proper procedure for setting up the cutting tool for facing. Discuss the tools necessary for locating centre holes and demonstrate drilling of centre holes in workpieces.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
9. Check lathe center alignments.	Place a sleeve and dead center in the head stock and a dead center in the tail stock. Show students the procedure involved for centering the dead center by adjusting the tail stock set screws.	
10. Properly center a cutting tool on the lathe.	Demonstrate the basic methods used for centering the tool on the lathe.	Methods of Centering Tool 1. Trial and error 2. Rule pressure 3. Visual dead center
11. Mount and turn work between centers.	Demonstrate to the students how to remove a lathe chuck and set up the work for turning between centers. Explain how to mount the face plate, lathe dogs, live and dead centers, as well as proper tool positioning.	
12. Mount and turn work in a lathe chuck.	Make students aware of the different types of lathe chucks. Point out that chucks should be oiled regularly, kept clean, and not overloaded or abused. Demonstrate thread cleaning with a thread-cleaning tool.	Types of Chucks 1. 3-jaw Universal 2. 4-jaw Independent 3. Collet chuck 4. Spindle chuck 5. Step chuck

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
13. Set up lathe for rough turning.	Using a rough turning tool demonstrate how to rough turn. Keep in mind the RPM, depth of cut, travel speed, and kind of material.	
14. Set up lathe for finish turning.	Repeat step 13 by using a finishing tool.	
15. Cut tapers with the compound rest.	Demonstrate to the students how to cut a taper by using a compound rest. Point out that the methods of turning tapers depend upon: a) the angle of the taper; b) the length of the taper; c) the number of pieces to be turned. Point out the compound rest method is best suited to turning short, steep tapers.	
16. Set up stock for drilling in a lathe chuck.	Demonstrate how to set up stock in a chuck for the purpose of drilling. Show the students how a pilot hole should be drilled by using a Jacobs chuck mounted in the tail stock.	
17. Set up stock for knurling.	Discuss the purpose and demonstrate the procedure for knurling. Emphasize the importance of having the knurling tool and workpiece tightened.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
18. Cut off stock with a parting tool.	Demonstrate how to do simple parting.	
19. Perform the proper procedure for finishing work on the lathe.	Demonstrate proper methods of filing and abrasive polishing on the metal lathe.	
20. Apply skills of measurement as required in lathe work.		
21. Grind a tool bit for lathe turning.	Point out that accurate work and good finishes cannot be done on the lathe without sharp cutting tools. Discuss shapes of the most-used lathe tool bits and the steps in sharpening them.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
F. MILL MACHINING The student should be able to:		
1. Describe the principle of milling.	Explain to the students that milling machines can machine flat horizontal, vertical, angular, and curved surfaces. They can also machine many kinds of shoulders, grooves, T-slots, keyways, etc.	Milling Cutting metal with a multiple-tooth cutting tool. The workpiece is mounted on the milling machine table and is fed against a revolving milling cutter.
2. Identify the types of milling machines.	Explain how milling machines are classified. The basic milling machines used in most school shops are the vertical and horizontal types. Discuss the practicality of each and indicate the machining procedures that may be performed on each.	Machine Types 1. Vertical 2. Horizontal 3. Combination Vertical and Horizontal
3. Identify various operations performed by milling machines.	Use handouts, transparencies, etc., and discuss the various types of mill cutters.	
4. Understand safety practices involved with milling machines.	Prepare a safety handout of a milling machine indicating principle parts to label and safety precautions to follow.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Identify the basic mill cutters.	Prepare a handout or transparency showing the basic types of mill cutters. Point out that high-speed steel cutting tools rank high in impact resistance, wear resistance, and toughness and are generally used on lightweight milling in school shops.	
6. Understand mill cutting speeds.	Discuss the factors which affect cutting speeds for milling operations, i.e.: a) kind of metal machined; b) Machineability rating of the metal; c) hardness of the metal (if heat treated); d) kind of cutting tool (high speed steel, cast alloy or carbide); e) whether proper cutting fluid is used; f) depth of cut and rate of feed (roughing or finishing).	Basic Mill Cutters A. Vertical Mill 1. END 2. Slot 3. Woodruff 4. T-Slot B. Horizontal Mill 1. Plain Mill 2. Slab Mill 3. Side Mill 4. Formed Mill 5. Slitting Saw
7. Set up stock in the milling machine.	Demonstrate the proper procedure for securing and setting up stock in a milling machine for the purpose of milling.	
8. Set proper mill cutting speeds.	Have students apply Imperial (Canadian) and SI metric formulas to calculating rpm's for milling and machining operations.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
9. Identify the proper lubricant for milling operations.	Discuss the importance of using cutting fluids for all milling operations on steel, aluminum, and copper alloys. Gray cast iron may be machined dry. Refer to charts identifying cutting fluids and their selection.	
10. Mill flat surfaces on the milling machine.	Demonstrate tool and work set-up procedure for milling a flat surface. Review the factors which affect cutting speeds for milling operations.	
G. SHAPER The student should be able to:		
1. Describe the principle of shaping.	Explain to the students that shaping is often referred to as planing and that the cutting tools used are similar to that on the lathe.	Shaping Cutting by moving either the tool or the workpiece back and forth in a straight line, with a cutting stroke and a return stroke.
2. Describe the application of the shaping principle to the shaper, planer, and slotter.	Explain the variations of the shaping principle as applied to the shaper, planer, and slotter.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
H. SHAPER OPERATIONS The student should be able to:		
1. Identify safety precautions involved when using the shaper.	Prepare a handout of the shaper indicating the major parts involved and the safety precautions to be followed.	
2. Identify the major parts of the shaper and describe the functions of each.	List the major parts of the shaper and explain the basic functions of each.	
3. Mount workpiece in the table vise.	Demonstrate the proper method of mounting a workpiece in the table vise.	
4. Select the proper cutting tool.	Prepare a chart showing the four basic shaper tool bits for mild steel shaping.	Basic Cutting Tools 1. General Purpose (Right hand) 2. General Purpose (Left hand) 3. Sidefacing (Left hand) 4. Flat Surface Finishing
5. Set the tool head.	Demonstrate the downward feed and angle settings on the tool head.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Set the stroke length.	Demonstrate setting the stroke length for efficient shaping, i.e., keeping the longest surface in line with the stroke.	
7. Set the table clearance underarm.	Demonstrate lowering and raising the table in order to obtain proper clearance.	
8. Adjust ram position.	Demonstrate adjusting the ram position so that the tool bit clears both ends of the workpiece by at least 12mm.	
9. Set table feed.	Demonstrate the table feed adjustment and explain that the feed depends on the cutting speed.	
10. Perform shaping operations.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
I. CAREERS The student should be able to: 1. Become familiar with careers related to machining metals.	Have students obtain literature outlining careers in metal machining. Display this material in your lab. Arrange field trips and tours of local metalwork industries.	CAREERS C - Concern, Cooperation, Choices, Competence A - Appearance, Attendance, Attitude R - Reading, 'Riting, 'Rithmetic, References E - Experience, Equality, Example E - Effective use of time R - Respect, Recognition S - Spirit

BASIC ARC WELDING ME-05

Major Objective: To obtain knowledge and skill related to the cohesion fastening of metals using the arc welding process.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. ARC WELDING INTRODUCTION The student should be able to: 1. Recognize and develop an understanding of safe arc welding procedures in the metal lab.	Have the students develop a listing of safe arc welding practices.	Arc Welding Safety 1. Always wear a helmet with the correct grade of filter lens. 2. Check lens for cracks before starting to weld. 3. Wear fire-resistant clothing at all times. 4. Use proper grounding. 5. Do not use holders with loose connections. 6. Do not change amperage or polarity while machine is under load. 7. Do not overload cables. 8. Do not weld in damp or wet areas. 9. Do not strike an arc without proper eye protection. 10. Do not pick up materials that have been welded. 11. Always wear eye protection when chipping slag. 12. Do not weld hollow castings that have not been properly vented. 13. Be sure to use proper types of spark shields. 14. Always keep a fire extinguisher handy.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
		15. Work in well vented areas. Welding (16mm film), Library, Manitoba Department of Education
2. Identify arc welding safety equipment.	Discuss with students the need for protective equipment in arc welding.	Safety Equipment 1. Helmets and shields 2. Safety glasses 3. Gloves 4. Aprons and jackets
3. Identify hand and power tools related to arc welding.	Describe the tools that are used in your particular lab that apply to basic arc welding.	Tools 1. Chipping hammer 2. Wire brush 3. Grinders 4. Clamps 5. Vise grips
4. Understand the principle of arc welding.	Describe to your students what takes place in the arc welding method of metal binding. Discuss the five essentials of arc welding, i.e., correct electrode, correct arc length, correct current, correct travel speed and correct electrode angle.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Identify arc welding equipment and accessories.	Have the students identify the main parts of an arc welder as well as the accessories used with each of the machines.	Arc Welding Equipment 1. Arc welder 2. Cables 3. Electrode 4. Ground clamp 5. Shielding screens
6. Understand basic arc welding terms.	Choose common terms used in arc welding technology and have the students write a definition of each.	Basic Terms 1. Electrode 2. Base metal 3. Bead 4. Ripple 5. Pass 6. Crater 7. Penetration 8. Polarity 9. Arc blow 10. Face and Root
7. Describe and recognize arc welding positions.	Point out that on many jobs it may be practically impossible to weld pieces only in one position. Discuss the four welding positions.	Welding Positions 1. Flat 2. Horizontal 3. Vertical 4. Overhead

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
8. Identify basic arc welding joints.	Explain that joint design is greatly influenced by the cost of preparing the joint, the accessibility of the weld, its adaptability for the product designed and welded, and the type of loading the weld is required to withstand. Have the students identify the basic joints and draw an orthographic view of each.	Basic Joints 1. Butt 2. Lap 3. Tee 4. Corner 5. Edge
9. List the group classification of electrodes.	Describe to the students the basic classifications of arc welding electrodes.	Classification of Electrodes 1. Mildsteel 2. High Carbon 3. Special Alloy 4. Cast Iron 5. Non Ferrous
10. Understand electrode number classification.	Using a defined electrode classification number explain to the students what each number or letter represents, e.g.: E-6011 -- E - Electrode 60 - Tensile strength 1 - position 1 - manufacturer's characterization	Charts - Welding Suppliers

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
11. Select the proper arc welding electrode.	Explain to the students how to choose an electrode pointing out that most selections are based on: a) type of metal welded; b) polarity; c) electrode; d) type of joint; e) amount of current used.	
B. ARC WELDING PROCEDURES The student should be able to:		
1. Identify the basic principles of sustaining a welding arc.	Explain to the students the purpose of sustaining a specific arc gap and how it relates to arc voltage and load current. Be sure to include other essentials such as electrode, current, electrode angle, and electrode travel speed.	
2. Develop the ability to strike an arc.	Demonstrate the two methods of striking an arc. Have the students start and stop the arc at least ten times before moving to stringer beads.	Methods 1. Tapping 2. Scratching

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Explain the procedure for making stringer beads.	Demonstrate the proper method of running stringer beads.	
4. Run a series of beads.	Have the students obtain small scrap pieces of metal and have them run a series of weld beads. (It is a good idea to use an easy welding rod such as the E-7014.)	
5. Explain the procedure for weaving.	Explain to the students the purpose of using the weaving technique and outline the different methods of weaving used in arc welding.	
6. Identify and explain arc welding defects.	Prepare a number of welds that are improperly done, indicating such defects as spatter, overlap, undercutting, poor penetration, and cracking. Show examples of these defects and compare them to metal welds that are properly done.	Welding Defects 1. Spatter 2. Overlap 3. Undercutting 4. Rough weld surfaces 5. Arc blow 6. Porosity 7. Poor fusion 8. Shallow penetration 9. Cracking

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
7. Weld basic joints in the flat position.	Demonstrate the proper techniques and have students follow them in arc welding basic joints. Emphasize safety precautions.	
C. RESISTANCE WELDING The student should be able to:		
1. Explain resistance welding.	Resistance welding is one of the most popular methods of bonding light sheet metal. Explain the procedure involved and have students identify industrial applications.	
2. Understand the applications of resistance welding.	Demonstrate resistance welding by using materials such as mild steel, galvanized metal, and tin plate.	
3. Describe the operations of spot welding.	Explain to the students the capabilities and limitations of the spot welder.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Weld metal using a spot welder.	Discuss the safety aspects to spot welding. Have the students practice spot welding, using scrap pieces of metal.	
D. CAREERS The student should be able to:		
1. Be familiar with the careers related to arc welding.	Have students obtain literature relating to careers in welding. Set up a display in your classroom.	

BASIC OXY-ACETYLENE WELDING ME-06

Major Objective: To obtain basic knowledge and skills related to the adhesion and cohesion fastening and separating of metals using the oxy-acetylene welding process.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. OXY-ACETYLENE WELDING SAFETY The student should be able to: 1. Identify the safety aspects pertaining to oxy-acetylene welding.	Discuss with your students the general safety rules regarding set-up and welding procedures. Acquaint students with the procedure of applying soap suds to all connections to test for leaks.	General Welding Safety Rules 1. Avoid contact with oil or grease. 2. Use a spark lighter. 3. Wear goggles. 4. Wear protective clothing. 5. Test for leaks using soapsuds. 6. Hang torches and hoses. 7. Do not light torch with both valves open. 8. Turn off valves upon completion. 9. Do not weld closed containers. 10. Secure tanks.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. OXY-ACETYLENE EQUIPMENT The student should be able to:		
1. List oxy-acetylene welding equipment.	Discuss with students the equipment that is required in order to be able to set up a oxy-acetylene welding station.	Oxy-Acetylene Equipment 1. Oxygen cylinder 2. Acetylene cylinder 3. Regulators 4. Hoses 5. Welding torch 6. Spark lighter 7. Goggles 8. Check valves
2. Understand the purpose of oxygen in oxy-acetylene welding.	Point out that oxygen itself does not burn but supports and speeds up combustion. Emphasize that a jet of oxygen should never be permitted to strike a substance that has oil or grease on it.	
3. Understand the purpose of acetylene in oxy-acetylene welding.	Explain that gas welding, one kind of fusion welding, uses a hot flame with a temperature of 6300 degrees F (3480 degrees C) that is produced by burning oxygen and acetylene in a welding torch.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Identify and describe the oxy-acetylene cylinders.	Describe to the students the different types of cylinders used for welding, indicating size, shape, colour and safe handling of oxy-acetylene cylinders.	
5. Identify the welding torch.	Explain to the students the type of torch used for welding, indicating proper positioning and hand control.	
6. Identify care procedures in handling a welding torch.	Demonstrate the proper safe handling of a welding torch.	
7. Identify the common sizes of welding tips.	Discuss with students the common weld tip sizes that are designed for particular welding.	Common Blowpipe Size 1. 00 2. 0 3. 1 4. 2 5. 3
8. Identify types of regulators.	There are two types of regulators: single stage and double stage. Explain to the students where each is used with reference to the type(s) in the school metalwork lab.	Types of Regulators 1. Single stage 2. Double stage

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
9. Describe the purpose of regulators.	Using charts or transparencies explain what a regulator is. Emphasize that gauges are fragile and care must be taken to have the adjusting screw released before opening the cylinder valve. (If the screw is not released, a sudden rush of gas could rupture the tube or diaphragm.)	
10. Identify the oxy-acetylene hoses.	Emphasize that oxy-acetylene hoses are colour coded: green for oxygen and red for acetylene. Oxy-acetylene hoses must be kept in good condition and never inter-changed.	
11. Identify uses of oxy-acetylene equipment.	Have students research and identify the uses of oxy-acetylene welding in manufactur-ing. Discuss the influence of technology and of changing materials on the manufacture of various products such as automobiles, furniture, etc.	Uses of Oxy-Acetylene Welding Equipment 1. Welding metal 2. Cutting metal 3. Normalizing metal by heating 4. Forging (shaping) metal 5. Shrinking metal 6. Soldering

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
C. OXY-ACETYLENE SET UP The student should be able to: 1. Describe set-up procedures for oxy-acetylene welding.	Use the welding text as a guide for the step-by-step procedure of setting up a welding station. Demonstrate and have the students set up and take down a portable welding unit.	Set-Up Procedures 1. Chain cylinders 2. Crack valves 3. Attach regulators 4. Connect hoses 5. Connect torch(es) 6. Test for leaks
D. OPERATING THE OXY-ACETYLENE UNIT The student should be able to: 1. Describe the starting-up procedure for oxy-acetylene welding.	This procedure is extremely important and should be done the correct way. Discuss with students the theory and the practice of the start-up procedures for oxy-acetylene welding. Quiz the students on this procedure.	Starting-Up Procedure 1. Install the correct tip. 2. Check regulator keys to ensure they are in the off position. 3. Open the acetylene tank valve one-half turn. 4. Open the oxygen tank valve all the way. 5. Set the regulators to the desired pressure. 6. Open the acetylene torch valve one-quarter turn.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
		7. Use a striker and light a flame. 8. Set proper flame. 9. Open oxygen torch valve to desired flame setting.
2. Light the oxy-acetylene torch.	Demonstrate this technique very carefully and thoroughly.	
3. Identify the oxy-acetylene welding flames.	Have the students identify the three basic welding flames by drawing and labeling them as well as lighting the torch and adjusting the flame setting.	Welding Flames 1. Carburizing 2. Neutral 3. Oxidizing
4. Demonstrate proper flame control.	Under teacher's supervision, have the student light the torch and display proper flame control.	
5. Recognize and identify backfire and flash-back.	Discuss with students the cause factors of flashback and backfire and explain prevention procedures. Backfire 1. Tip touching the work 2. Overheated or dirty tip 3. Loose torch head or tip 4. Lower than recommended gas pressure 5. Poor seal between torch body and mixing chamber	Flashback Fire inside the torch. Backfire Back of flame momentarily burning into the tip.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	Flashback 1. Insufficient gas pressure 2. Improper use of the torch	
6. Describe the procedure for shutting off the oxy-acetylene system.	Demonstrate the step-by-step procedures used to shut off the oxy-acetylene system.	Shut-Off Procedure 1. Close the acetylene torch valve. 2. Close the oxygen torch valve. 3. Close the oxygen tank valve. 4. Close the acetylene tank valve. 5. Open the acetylene and oxygen torch valves to bleed lines and regulators (bleed separately). 6. Close the oxygen and acetylene torch valves. 7. Close the oxygen and acetylene regulators.
7. Demonstrate the proper procedure for shutting off the oxy-acetylene torch.	Have each student light and shut off the oxy-acetylene torch.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
E. MATERIALS The student should be able to:		
1. List types of metals that could be welded by the oxy-acetylene process.	Discuss and have students prepare a listing of the basic types of metal materials that may be welded by the oxy-acetylene process.	Types of Metals 1. Aluminum 2. Brass 3. Bronze 4. Copper 5. Iron (Gray Cast) 6. Lead 7. Steel (Mild) 8. Tin 9. Zinc
2. Understand the melting points of common metals.	Point out the temperature of an oxy-acetylene flame is approximately 3400 degrees C and is capable of welding most metals.	Common Metals and Their Melting Points 1. Aluminum 660° C 2. Brass 900° C 3. Bronze 906 C 4. Copper 1083° C 5. Iron (Gray Cast) 1260° C 6. Lead 327 C 7. Steel (Mild) 1504° C 8. Tin 232 C 9. Zinc 420 C

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Select and prepare metal material for welding.	Have students obtain pieces of 14 to 16 gauge mild steel for oxy-acetylene welding. (Metal thicker than 10 to 12 gauge should be arc welded.) Demonstrate the proper method of preparing the metal pieces for welding.	
F. OXY-ACETYLENE WELDING IN THE FLAT POSITION The student should be able to:		
1. Apply the safety procedures to oxy-acetylene welding.	Review safety precautions for oxy-acetylene welding.	
2. Define <u>cohesion</u>.		<u>Cohesion</u> Fusion through the attraction of molecules.

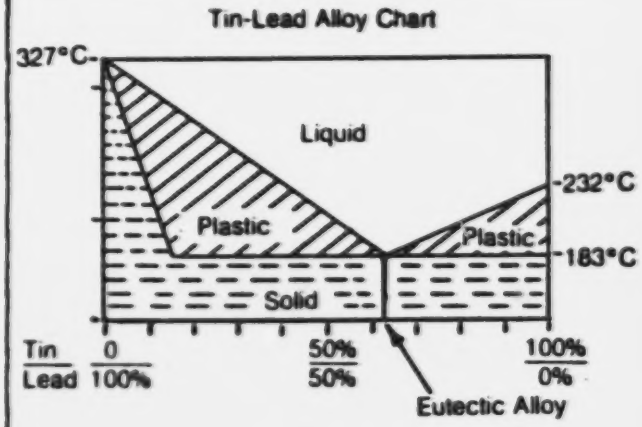
OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Demonstrate the ability to puddle.	Obtain a small piece of light gauge mild steel and demonstrate to the students how to run a puddle without applying a filler rod.	
4. Demonstrate the ability to run a bead.	Demonstrate to students the proper procedure to puddle and apply a filler rod at the same time. Have the students practice this procedure on scrap stock.	
5. Identify the basic weld joints.	Have the students sketch orthographic views of the basic weld joints.	Basic Weld Joints 1. Butt 2. Lap 3. Tee 4. Corner 5. Edge
6. Weld basic joints.	Obtain small pieces of scrap stock (approx. 3mm thick) and demonstrate the proper procedures used in welding joints. Have students practice with and without filler rods.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
G. OXY-ACETYLENE BRAZING The student should be able to:		
1. Define <u>adhesion</u>.	Discuss and have students prepare a definition for adhesion.	<u>Adhesion</u> A process of bonding two surfaces with a dissimilar material.
2. Define <u>brazing</u>.	Discuss and have students prepare a definition for brazing.	<u>Brazing</u> The process of joining two pieces of metal with a metal-brazing material.
3. Identify advantages and disadvantages of brazing.	Point out that brazing is performed in the same manner as fusion welding except that the base metal is not melted.	<u>Advantages</u> 1. Base metal does not have to be heated to a molten condition 2. Malleable metal is less likely to lose its ductile properties 3. Minimum expansion and contraction (low heat) 4. Less need for extensive preheating <u>Disadvantages</u> 1. Not recommended for those parts whose service temperature may be higher than the melting point of bronze 2. Cannot be used on metal where stress is a factor 3. Corrosion properties may differ from the base metal

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Describe the purpose of flux.	Explain to the students the purpose of the flux for welding. Point out that the flux must: a) prevent oxidation; b) improve the flow of the filler metal; c) be easy to clean with water.	
5. Identify the types of brazing flux.	Explain the different types of fluxes available on the market today. Refer to study tables for the correct use of commercially available brazing fluxes.	Types of Flux 1. Powder 2. Paste or liquid 3. Solid coating preapplied on the filler metal 4. Vapor
6. Describe the characteristics of filler metals.	Refer to study tables for data concerning the correct filler metal to use for brazing different base metals. Point out that the American Welding Society lists filler metals under the following classifications: aluminum-silicon, copper-phosphorus, silver, gold, copper and copper-zinc, magnesium, and nickel.	Characteristics of Filler Metal 1. Ability to wet and flow 2. Suitable melting temperature 3. Stability 4. Availability a) wire b) rod c) strip d) powder
7. Prepare metal for brazing.	Demonstrate to the students how to prepare metal for brazing and discuss the reason the metal should be cleaned. Also discuss methods of cleaning metal materials, e.g., emery cloth, sandblasting, etc.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
8. Use the brazing process to join metals.		
H. FLAME SOLDERING The student should be able to:		
1. Explain the difference between soft and hard soldering.	Explain the different techniques of soft and hard soldering. A demonstration should include the different types of fluxes used, the proper preparation of metal and the proper types of flame control required for good, strong soldered joints. Outline the safety aspects of soldering.	Soft Soldering A metal joining process using low-melting point solder. Hard Soldering A metal joining process that utilizes silver solder and high temperature.
2. Identify fluxes used for soldering.	Discuss with the students the purpose and use of the different types of flux.	

FLUX	UTILIZATION
Rosin	Electric Circuits
Soldering Paste (Zinc Chloride + Ammonium Chloride + Vaseline)	Tinplate Copper Brass
Zinc Chloride	Steel
Muriatic Acid (HCl)	Galvanized Iron
Phosphoric Acid	Stainless Steel

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Describe the composition and characteristic of solder.	Explain to the students that soft solders for most metals, such as galvanized iron, tin plate and copper, are made from a combination of tin and lead.	
4. Use the flame soldering process to join metal.	Have students demonstrate the proper technique of flame soldering. Place emphasis on workpiece preparation, flame temperature and control, type of joint, type of flux, and type of solder used.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
I. OXY-ACETYLENE CUTTING The student should be able to:		
1. Identify the oxy-acetylene cutting equipment.	Point out to students that the only difference between this equipment and that used in oxy-acetylene welding is the cutting torch attachment.	Oxy-Acetylene Cutting Equipment 1. Oxygen cylinder 2. Acetylene cylinder 4. Hoses 5. Cutting torch 6. Spark lighter 7. Goggles
2. Describe the procedure for using the cutting torch.	Prepare for the students a specific step-by-step procedure for using the cutting torch. Be sure to include gas pressures, type of flame used, torch control, etc. Have students develop a chart of gas pressures for different sizes of cutting tips.	
3. Set up the cutting torch.	Point out that oxy-acetylene cutting is limited to the cutting of ferrous materials. Stainless steel, manganese steels, and non-ferrous materials are not readily cut because they do not oxidize rapidly.	

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Perform oxy-acetylene cutting procedures.	Have students obtain scrap pieces of metal plate (approx. 6mm thick) and perform torch cutting. Point out that the thicker the metal that is to be cut, the larger the size of the hole in the cutting tip.	
J. CAREERS The student should be able to:		
1. Be familiar with careers in oxy-acetylene welding.	Have the students develop a display board with information and brochures related to career opportunities in welding.	

SHEET METAL ME-07

Major Objective: To acquire information about the industrial use and processing of sheet metal and to gain a basic understanding and skills in sheet metal work.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. MATERIALS **The student should be able to:**		
1. Identify the common types of sheet metal.	Have students prepare a display of various sheet metals.	Common Sheet Metals 1. Mild steel 2. Galvanized 3. Aluminum 4. Cooper 5. Brass 6. Brass plated steel 7. Chrome plated steel 8. Tin plate
2. Describe how sheet metal is manufactured.	Using charts, films, transparencies, etc., outline how sheet metals are produced.	
3. Identify common sheet metal products.	Point out that objects of sheet metal can be found everywhere. Examples are: signs, automobiles, containers, toys, desks, mail-boxes, machine cabinets, file cabinets, televisions, etc.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Identify standard sheet metal sizes.	Have the students research the available sheet sizes and do a cost comparison of each.	
5. Demonstrate safe handling of sheet metal.	Make students aware of potential hazards in handling sheet metals.	
B. PATTERN DEVELOPMENT METHODS The student should be able to:		
1. Identify the methods of pattern development.	Demonstrate that a stretchout pattern is a full-sized drawing of the product/project on a single plane.	Methods of Pattern Development 1. Straight line 2. Parallel line 3. Radial line 4. Triangulation

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Describe the use of each method of pattern development.	Show examples of each method of pattern development, i.e.: a) straight line - boxes, trays; b) parallel line - pipes, bands, scoops; c) radial line - funnels, buckets, tapered lampshades; d) triangulation - pipe and ductwork, joining square and round shapes.	Simple Developments, 16mm, colour film, Library, Manitoba Education Introduction and Overview, Straight Line Pattern Development, Parallel and Radial Line Pattern Development, (colour filmstrips, cassettes, study guide), McIntyre Educational Media
3. Produce patterns by using two different development methods.		
C. LAYOUT TOOLS AND TECHNIQUES The student should be able to:		
1. Identify layout tools for sheet metal work.	Explain that a stretchout or pattern can be drawn directly on the metal, but most often the pattern is developed on paper and then transferred to the metal.	Layout Tools 1. Rules 2. Squares 3. Scribers/scratch awls 4. Prick punches 5. Dividers 6. Protractors 7. Transfer fluids 8. Hammers 9. Trammel points

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Describe techniques of sheet metal layout.	Explain and demonstrate methods of tranferring patterns to metal, i.e.: a) carbon paper transfer; b) prick punch around patterns; c) tracing around patterns.	
3. Demonstrate proper techniques of sheet metal layout.		
D. SEPARATING TOOLS AND TECHNIQUES The student should be able to:		
1. Identify sheet metal separating tools and equipment.	Discuss methods of separating sheet metal.	Tools and Equipment 1. Snips 2. Notchers 3. Squaring shears 4. Punches 5. Chisels 6. Saws 7. Nibblers 8. Drills

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Explain the use of sheet metal separating tools and equipment.	Through class discussions and demonstrations, explain sheet metal separating tools and equipment. Emphasize safety precautions and procedures.	Straight Cutting with Snips, Laying Out and Cutting a Rectangle, Laying Out and Cutting A Square, (filmstrips, cassettes, worksheets, student's guide), Nelson Canada
3. Demonstrate proper techniques in separating sheet metal.		
E. FORMING TOOLS AND TECHNIQUES The student should be able to:		
1. Identify sheet metal forming tools.	Explain that sheet metal can be bent into dozens of possible shapes, each according to the kind of project.	Forming Tools 1. Bar folder 2. Box and pan brake 3. Slip roll 4. Combination rotary machine 5. Bench stakes 6. Hand formers
2. Explain the purpose of various forming tools and equipment.	Demonstrate forming techniques using the forming tools and equipment in the metal work lab.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Demonstrate proper techniques in the use of sheet metal forming tools and equipment.		
F. FASTENING SHEET METAL The student should be able to:		
1. Identify methods of fastening sheet metal.	By means of sample pieces, acquaint the students with the common methods of fastening sheet metal.	Methods of Fastening Sheet Metal 1. Mechanical Fasteners a) threaded b) unthreaded c) seams d) intrinsic and extrinsic 2. Adhesion a) cementing b) brazing c) soldering 3. Cohesion a) resistance welding
2. Select suitable methods of fastening sheet metals.		Solder and Soldering, (16mm colour film), Library, Manitoba Education

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Demonstrate proper techniques of fastening sheet metal.		
G. FINISHING SHEET METAL The student should be able to:		
1. Surface-coat metal with organic/inorganic finishes.	Prepare a brief presentation on sheet metal finishing, listing methods by which metal may be finished and demonstrate proper techniques used for applying organic and inorganic finishes.	Coatings 1. Paints 2. Ceramics 3. Plating
2. Apply a physical finish to sheet metal.	Demonstrate how to apply a physical finish by sanding, polishing, peening, blasting, and engraving.	Physical Processes 1. Sanding 2. Polishing 3. Peening 4. Blasting 5. Engraving
3. Apply a chemical finish to sheet metal.	Emphasize safety to finishing sheet metals.	Chemical Processes 1. Etching 2. Bluing 3. Flame colouring 4. Anodizing

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
H. CAREERS The student should be able to: 1. Identify careers related to sheet-metal work.	Through class discussion, research, visuals, speakers, etc., aid students in acquiring knowledge of and opportunities in sheet-metal work.	

BENCH METAL ME-08

Major Objective: To acquire information about the industrial use and processing of bench metal and to gain a basic understanding and skill in bench metal work.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. MATERIALS The student should be able to:		
1. Identify common types of metals used for bench metal work.	Discuss and demonstrate common types of metals used for bench metal work.	Types of Metals 1. Mild steel 2. Aluminum 3. Stainless steel 4. Cast iron 5. Brass 6. Lead 7. Zinc
2. List common metal shapes and sizes used for bench metal work.	Have students prepare a design problem outlining various types, shapes, and sizes of bench metal.	Common Shapes 1. Sheet 2. Plate 3. Band 4. Rod 5. Square 6. Flat 7. Hexagon 8. Octagon 9. Angle 10. Channel 11. I-Beam 12. Expanded 13. Tubing

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
		Rolling Steel in Selkirk, Steel Rhythm, (16mm films), Library, Manitoba Education
B. LAYOUT TOOLS AND TECHNIQUES The student should be able to:		
1. Identify layout tools for bench metal work.	Demonstrate the need for accuracy in measurement and layout before separating or forming of the material takes place.	Layout Tools 1. Rules 2. Squares 3. Scribers/scratch awls 4. Layout punches 5. Dividers 6. Hermaphrodite calipers 7. Protractors 8. Surface gauges 9. Hammers
2. Describe the purpose of various layout tools.	Make students aware of the theory related to layout tools, i.e.: a) measuring, b) marking layout, c) geometric line and angle division, d) geometric constructions, e) views and projections.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Apply proper techniques in the use of layout tools.		
C. SEPARATING TOOLS AND TECHNIQUES The student should be able to:		
1. Identify separating tools for bench-metal work.	Demonstrate the various separating tools and discuss safe operating techniques.	Separating Tools 1. Hacksaws/bandsaws 2. Bench shears 3. Beverly shears 4. Diagonal cutters 5. Cold chisels 6. Files 7. Drills 8. Punches 9. Grinders 10. Cutting torches
2. Describe the purpose of various bench-metal separating tools.	Demonstrate proper techniques of securing bench metal. Emphasize the importance of selecting the proper tool for the given job.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Apply proper techniques in the use of separating tools.	Provide students with opportunities to use various types of bench-metal separating tools.	
D. FORMING TOOLS AND TECHNIQUES The student should be able to:		
1. Identify tools for forming bench metal.	By means of sample pieces acquaint the students with the different methods of forming metals by use of various forming tools and techniques.	Forming Tools 1. Bench vises 2. Bending bars 3. Tap wrenches 4. Bending jigs 5. Diacro benders 6. Hossfeld benders
2. Describe the purpose of various bench-metal forming tools.	Point out that many metal alloys are so ductile that they can be hammered and sharply bent without cracking or breaking. Also, if a part requires many bends, it is necessary to plan the bending order carefully.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Apply safe procedures in forming bench metal.	Demonstrate to students that to determine the length of a straight piece needed, one has to add to the inside dimensions of the bent piece a bend allowance of 1/3 to 1/2 the metal thickness for each bend (1/3 for soft metals and 1/2 for hard metals).	
E. FASTENING METHODS The student should be able to:		
1. Identify methods of fastening bench metal.	By means of sample pieces, acquaint the students with the common methods of fastening bench metal. Explain each method with a discussion as to applications of each.	Fastening Methods 1. Mechanical Fasteners a) threaded b) unthreaded c) intrinsic and extrinsic d) seams 2. Adhesion a) cementing b) soldering c) brazing 3. Cohesion a) oxy-acetylene welding b) arc welding c) resistance welding

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Identify common screw thread series.	Acquaint students with thread forms and emphasize the importance of selecting the appropriate tools for producing various threads.	Common Thread Series 1. Imperial a) American National (Unified) Coarse (NC) b) American National (Unified) Fine (NF) 2. Metric a) International Organization for Standardization (ISO) b) Industrial Fasteners Institute (IFI) SI Metric Guide: Technical Education, Province of Manitoba, Department of Education, 1979
3. Select appropriate tools for producing internal and external threads.	Explain the proper care and handling of each tool and demonstrate the proper way to use each tool.	
4. Perform basic hand threading operations using taps and dies.	Point out that cutting fluids greatly reduce the strain and should be used with dies or when tapping most metals.	
5. Identify tools for reaming techniques.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Demonstrate appropriate procedures to fastening bench metal.	Emphasize that care should be taken to provide fastening areas in the joint design large enough to withstand calculated loads.	
F. FINISHING PROCEDURES The student should be able to:		
1. Identify methods of finishing bench metal.	Point out that most metal products manufactured by modern industry require some kind of finishing. Emphasize that the metal finishes have been developed to meet the needs of industrial and technological processes, products, and developments. Point out that all metal finishing processes may be grouped into these three major categories: . adding material to metal surface by combining processes; . removing material from metal surface by separating processes; . giving some mechanical treatment to the metal surface by forming processes.	Finishing Methods 1. Mechanical 2. Physical 3. Chemical Peening, Finishing and Assembly, (colour filmstrip, cassette, study guide), McIntyre Educational Media
2. Demonstrate finishing techniques.	Show students examples of each category and ask them to identify the many kinds of finishes used on common metal products.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
G. CAREERS The student should be able to: 1. Identify careers related to bench-metal work.	Through class discussion, research, visuals, tours, speakers, etc., aid students in acquiring knowledge of careers related to bench-metal work.	

FOUNDRY PRACTICE ME-09

Major Objective: To gain knowledge and skill related to metal casting and to use, care, and maintain tools and equipment applicable to the foundry process in the metal lab.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. THE CASTING PROCESS The student should be able to:		
1. Identify casting procedures.	Explain that the casting process utilizes a mold cavity formed from a pattern that is surrounded by a medium which can withstand the problems created by the flow of molten metal.	Casting Procedures 1. Sand casting 2. Die casting 3. Investing (lost wax) casting
2. Describe casting procedures.	Have students study classification charts related to metal casting methods and molds. Have them compare casting methods under these headings: mold material used, types of metals being cast, types of molds, and typical products resulting from casting.	Sand Casting A process which involves pouring molten metal into a cavity that has been formed in a sand mold. Die Casting A method of casting metal under pressure by injecting it into metal dies of a die-casting machine. Investment Casting A process that involves making a wax or plastic pattern, surrounding it with a wet refractory material, melting or burning the pattern after the investment material has set and dried, and pouring metal (vacuum or centrifrigal force) into the cavity.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Develop an awareness of safety precautions in the casting process.	Prepare a handout listing safety precautions on casting.	Tools and Equipment, Preparing and Pouring One-Piece Casting (Parts 1 and 2), Preparing a Split Pattern Casting, (colour filmstrips and cassettes), Foundry Work Series, McIntyre Educational Media
4. Identify common tools and equipment related to the sand-casting process.	Prepare a handout illustrating examples of tools and equipment used in the casting process.	Foundry Equipment 1. Flask 2. Molding board 3. Strike off bar 4. Riser pin 5. Sprue pin 6. Bench rammer 7. Gate cutter 8. Riddle 9. Bellows 10. Trowel 11. Slick and oval
5. Identify factors of good foundry sand.	Discuss the advantages and disadvantages of green sand and synthetic oil base sand.	Factors 1. Thermal stability 2. Flowability 3. Collapsibility 4. Recycling potential 5. Ease in preparation

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Identify metals used for casting.	Make students aware of various types of metals used for casting. Outline the melting points of major metals used in a school laboratory.	Casting Metals 1. Brass 2. Bronze 3. Aluminum 4. Lead
7. Identify patterns used for sand casting.	Discuss the basic types of patterns used in casting. There are two basic patterns: simple and split. Produce samples of these types of patterns.	
8. Make a mold using a simple pattern.	Demonstrate proper procedures in casting simple patterns.	
9. Make a mold using a split pattern.	Demonstrate the operations in casting a foundry split pattern.	
10. Prepare metal for melting.	Demonstrate furnace lighting procedures. Point out that if additional metal must be added to the crucible, precaution must be taken to prevent metal with moisture from being added to the molten metal. Discuss metal-pouring temperatures and demonstrate the use of a pyrometer, adding of flux, and skimming the slag.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
11. Pour metal into mold.	Demonstrate to the students the proper technique of pouring metal into the mold. Emphasize the need for safety apparel and safety procedures.	
12. Remove the casting	Be sure the metal is properly cooled in the mold before it is removed. When the casting is ready to be removed, demonstrate for students the proper casting-removal procedures.	
13. Identify technological developments in metal casting.	Acquaint student to the V-Process foundry casting technique. This new concept involves rigidizing the sand mold by vacuum packaging it in plastic film during mold manufacture.	Herman-Sinto V-Process Corp. Zelienople, PA, 16063, USA V-Process (16mm film), Herman-Sinto Corp.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. FINISHING THE METAL CASTING The student should be able to:		
1. Identify common methods for finishing castings.	Describe and demonstrate various methods used for finishing a casting.	Finishing Methods 1. Filing 2. Sanding 3. Blasting 4. Polishing/Buffing 5. Turning 6. Coating
2. Finish the metal casting.	Have the students cast a product and finish the casting by filing, polishing, machining, or applying a commercial finish. Review safety procedures.	
C. CAREERS The student should be able to:		
1. Be familiar with careers related to foundry manufacturing.	Obtain literature pertaining to the foundry industry so that students may become aware of some of the careers available within the field. Display this material in your classroom.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
D. PATTERNS (Optional)		
The student should be able to:		
1. Make a simple pattern for casting.	Review pattern materials and have students design and produce a simple pattern for casting using wood, styrofoam (sm), ceramic clay, or plaster of paris.	
2. Make a split pattern for casting.	Review the procedure involved in casting with a split pattern.	

FORGING PRACTICE ME-10

Major Objective: To understand the process of metal forming by forging and develop basic hand forging skills in the metal laboratory.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. INTRODUCTION The student should be able to:		
1. Define <u>hand forging</u>.	Explain and discuss with the students that forging is the application of force on hot metal. Heated metal generally exhibits greater pliability. This is particularly true for steel and its alloys. Within certain boundaries, the higher the carbon content of steel, the lower the forging temperature. Forging must not be attempted at any time when the metal has cooled below the upper critical point. Forging below the upper critical point will result in cracks and unseen grain damage that will ultimately lead to metal fracture.	<u>Forging</u> A forming of hot metal by hammer blow or pressure.
2. Identify the advantages of forging metal.		<u>Advantages</u> 1. Improve quality of metal 2. Refine the grain structure 3. Increase strength and toughness
3. Identify the safety aspects pertaining to metal forging.	Acquaint students with safety practices and procedures in metal forging.	

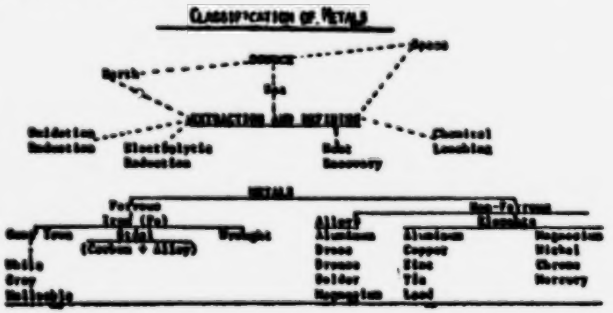
OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. TOOLS AND EQUIPMENT The student should be able to:		
1. List the tools and equipment used for hand forging.	Demonstrate to the students the basic shop tools and equipment used for hand forging. Outline the forging methods used, the objects that can be forged, and the forging process.	Forging Equipment 1. Forge 2. Tongs 3. Anvil 4. Hammer 5. Set tools
2. Light the equipment used for forging.	Demonstrate how to light the various heat sources (acetylene torch, forge, and heat treating furnace).	
C. FORGING PRACTICES The student should be able to:		
1. Draw out metal by forging.	Demonstrate to the students how to heat a piece of steel to forging temperature and how to perform operations by drawing, tapering, bending, twisting, and upsetting metal with the use of hammers, tongs, anvils and anvil tools.	Drawing Out A process to make a piece longer and thinner.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Taper metal by forging.	Discuss heat colours and comparable temperatures of steel.	Tapering A shaping process for forming such tools as cold chisels and centre punches.
3. Bend metal by forging.	Demonstrate various ways of bending sharp square bends and circular, curved bends.	
4. Twist metal by forging.	Discuss jig design.	
5. Upset metal by forging.	Demonstrate the use of a vise for this process.	Upsetting A shaping process opposite to drawing out (increasing the areaof metal by decreasing its length).
6. Finish forged metal.	Demonstrate various methods of finishing metal.	
7. Heat-treat metal formed by forging.	Review basic heat treating outlined in the metallurgy and heat-treating module.	
8. Describe the industrial applications for forging.	Have the students prepare a report outlining machine forging and other hot-forming processes.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
D. CAREERS The student should be able to: 1. Be familiar with occupations related to forging.	Through class discussion, visuals, research, etc., assist students in acquiring knowledge of and opportunities in metalwork forging.	

METALLURGY AND BASIC HEAT TREATMENT ME-11

Major Objective: To gain a basic knowledge of the science and technology of metals and to develop an understanding of the importance and processes of the heat-treatment of metals.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. METALLURGY The student should be able to:		
1. Define <u>metallurgy</u>.	Have students prepare a definition of metallurgy.	<u>Metallurgy</u> The science and technology of making metals and alloys for practical use.
2. Understand the classification of metals.	Use a chart as follows to explain the classification of metals: 	
3. List the properties of metals.	Provide information on and explain the physical properties of metals. Explain that ongoing studies related to metal properties have resulted in alloys with reduced mass and increased strength, thus improving metal products such as automobiles, airplanes, and other commodities.	<u>Properties of Metals</u> 1. Chemical 2. Physical 3. Mechanical

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Describe the physical properties of metals.	Using the following chart, discuss the identification of physical properties of metals. **Identification** Silverish — Color — Reddish, Yellow Solid — Physical State — Liquid Light — Weight — Heavy Magnetic — Magnetism — Non-Magnetic High — Thermal Conductivity — Low Good — Electrical Conductivity — Poor	Physical Properties 1. Colour 2. Physical state 3. Weight 4. Magnetism 5. Thermal conductivity 6. Electrical conductivity
5. Describe the mechanical properties of metals.	Point out that knowledge of the properties of various metals and alloys is important to the intelligent selection and processing of metals for products.	Mechanical Properties 1. Strength 2. Hardness 3. Brittleness 4. Malleability 5. Ductility 6. Elasticity 7. Fusibility 8. Machinability

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Define ferrous and non-ferrous metals.	Point out that iron as a pure metallic element is not suitable for use in industry; however, the addition of a small amount of carbon will produce cast iron, wrought iron, and steel.	Ferrous A family of metals in which iron is the main ingredient; usually magnetic. Non-Ferrous Metals containing no iron; non-magnetic.
7. Identify common types of metals.	Prepare a display of various ferrous and non-ferrous metal samples.	
8. Identify metal coding systems.	Point out the different methods of coding metals. Discuss the SAE/AISI, and the colour coding systems of steel. Demonstrate metal identification by means of the "spark test".	SAE Society of Automotive Engineers AISI American Iron and Steel Institute
9. Describe how steel is manufactured.	Have students prepare research assignments on how steel is produced and manufactured for commercial use. Discuss different grades of structural steels, alloy steels, tool steels, specialty steels, etc.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
10. Understand how most steel is shaped.	Discuss hot rolled and cold rolled shaping processes. Arrange a tour of a steel mill.	
B. BASIC HEAT TREATMENT The student should be able to:		
1. Define heat treatment.	Point out that heat treating can give metal specific properties needed to do a job.	Heat Treatment The heating and cooling of metals in their solid state in order to change their properties.
2. Describe the properties of steel that can be changed by heat treatment.	Review the following properties: hardness, brittleness, toughness, tensile strength, ductility, malleability, machinability, and elasticity. Discuss the effects of carbon content and heat treatment.	Elements of Hardening, Elements of Surface Hardening, Elements of Tempering, Normalizing, and Annealing (16mm colour films), Library, Manitoba Education
3. List the principal kinds of heat treatment processes.	Point out that all heat treatment processes involve heating and cooling metal according to time/temperature cycle that includes these steps: a) Heating the metal to a certain temperature; b) Holding the metal at this elevated temperature for a certain period of time; c) Cooling the metal at a certain rate.	Heat Treatment Processes 1. Annealing 2. Hardening 3. Tempering 4. Normalizing 5. Case hardening 6. Flame hardening 7. Induction hardening 8. Laser hardening

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Identify heat treatment furnaces.	Point out that the various heat treatment processes require that steel parts be heated at precise temperatures in temperature-controlled furnaces.	Kinds of Furnaces 1. Electric 2. Gas-fired
5. Define annealing.		Annealing A heat treatment process that removes hardness from metals by relieving internal stress.
6. Describe the procedure for full annealing.	Discuss and demonstrate the following procedure: a) Heat the item to a temperature of 760 degrees to 875 degrees C. b) Allow item to soak in heat for 1 hour per 25mm thickness. c) Allow the item to cool slowly. (This may be done by shutting off the furnace and letting the item cool in the cooling furnace or by removing the item and placing it in ashes or lime.)	
7. Perform operations safely in annealing metal material.		

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
8. Define hardening.		Hardening A heat-treating process in which steels are heated slowly to a certain temperature and then cooled rapidly in a solution.
9. Describe the procedure for hardening carbon tool steel.	Discuss and demonstrate the following procedure: a) Place shaped tool in furnace and heat to 790 degrees C (cherry-red colour). b) Check for verification that the metal is non-magnetic. c) Quench the cutting end with 1/3 of the length in water. d) Remove from quenching medium and polish tip surface with emery cloth. e) Temper with colours advancing from hot body towards tip. f) When desired tempering colour reaches tip immerse the whole tool to arrest further tempering. g) Dress tool to correct cutting edge.	
10. Perform operations safely in hardening carbon tool steel.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
11. Define <u>tempering</u>.		<u>Tempering</u> A heat-treating process to relieve internal stress and increase toughness of steel.
12. Explain the tempering process.	Discuss and demonstrate the following procedure: a) Clean surface with emery cloth. b) Heat to proper tempering temperature and hold for one hour per 25mm of item thickness. c) Quench when the tempering colours reach the point.	
13. Perform operations safely in tempering carbon tool steel.	Point out that items or parts that are 6mm or less in thickness do not require any extended soaking in heat.	
14. Define <u>normalizing</u>.		<u>Normalizing</u> A heat-treating process that relieves internal stress and removes the effects of other heat treatment processes.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
15. Describe the procedure in normalizing carbon steel.	Discuss and demonstrate the following procedure: a) Heat a forged item to a temperature of 850 to 900 degrees C. b) Allow the item to soak at the normalizing temperature for a period of approximately 1 hour per 25mm of thickness. c) Remove from heat and allow to cool in air.	
16. Perform operations safely in normalizing carbon steel.		
17. Define case hardening.		Case hardening A heat-treating process of applying a carbonaceous substance to the surface of steel and soaking the steel to produce a surface layer of iron carbide.
18. Describe the case-hardening process.	Point out that case hardening is a slow surface-hardening process. Demonstrate the following procedure: 1. Heat item to an orange-red colour. 2. Coat item with carburizing material and allow to soak in the carburizing temperature, i.e., 10 hours for a depth of 2mm. 3. Quench in water.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
19. Perform safely case-hardening procedures.	Point out that direct quenching reduces oxidation scale build-up, thus resulting in less difficulty in cleaning.	
20. Explain the flame-hardening process and its use.	Have students research this method of heat treatment, providing examples and explaining the procedure involved.	
21. Explain the induction-hardening process and its use.	Point out that this process is similar to flame hardening except that a high-frequency electric current is used.	
22. Explain the laser and electron beam hardening process.	Have students research these methods of heat treatment. Point out that heating is so rapid with these methods that metal next to the heated area remains cold. This enables heat to be conducted away so quickly that hardening occurs without quenching.	
C. POWDER METALLURGY The student should be able to:		
1. Define powder metallurgy.		Powder Metallurgy The technology of producing metal parts by compressing metal powders in precision dies or molds.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. List the main types of powder-metal materials.	Explain that metal powders are sometimes mixed with non-metal powders and used as the raw material for metal products.	Powder-Metal Materials 1. Iron Base 2. Copper Base 3. Other
3. Identify advantages of the powder-metal process.	Point out the unusual features which make the powder-metal process especially important, i.e.: a) it enables materials to be combined that previously could not be combined; b) it permits parts of controlled density or porosity to be made; c) it is very economical because machining and finishing are generally not required.	
4. Identify uses of powder-metal parts.	Point out that the largest user of powder-metal parts is the automotive industry. The small appliance and portable power tool industries are also large consumers of powder-metal parts.	Uses of Powder-Metal Parts 1. Drive mechanisms 2. Mechanical parts 3. Filters 4. Magnets and magnetic cores for electrical and electronic uses

ART METAL ME-12

Major Objective: To develop an appreciation for one of the oldest and most intricate forms of metalwork and to provide the student with the opportunity to create articles of beauty and personal design.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Identify tools used in working with art metal.	Prepare a detailed handout outlining the various tools and equipment that can be used for art metal.	Art Metal Tools 1. Art metal hammer 2. Art metal mallet 3. Art metal stakes 4. Jeweler's saws 5. Jeweler's files 6. Fluting tools 7. Etching tools 8. Tooling instruments Basic Metalwork Procedures, Wedge, UBC
2. Identify metals used for art metal.	Prepare a small display board containing most of the metals used in art work.	Metals Used for Art 1. Copper 2. Brass 3. Aluminum 4. Pewter 5. Plated steel
3. Identify methods of surface decoration.	Make the student aware of the basic terms used in art metal surface decoration and provide a brief description of each.	Methods of Surface Decoration 1. Peening 2. Piercing 3. Overlaying 4. Tooling 5. Chasing (metal tapping) 6. Doming

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
		7. Engraving 8. Stamping 9. Enamelling
4. Anneal different types of metal used for art work.	Demonstrate different annealing methods as applicable to the metals being used.	
5. Draw and transfer designs on metal.	Explain that a design can be drawn directly on metal, but most often is developed on paper and then transferred to the metal.	
6. Engrave a design on metal.	Demonstrate how designs may be engraved on metal by the use of engraving tools.	
7. Describe metal etching.	By showing samples of etched pieces of metal, explain that etching is the controlled removal of material from specific areas of a base metal through the chemical action of an etchant. The areas to be etched are outlined by a resist or stopping-out varnish. It is important that the base metal be polished to the degree of finish required before a resist is applied to the metal surface, because it is virtually impossible to polish a metal surface without damaging the lower etched area.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
8. Etch various metals.	Outline the safety procedures involved with metal etching.	
9. Clean metal by pickling.	Demonstrate the proper method of cleaning metals by the use of an appropriate pickling solution. NOTE: BE SURE TO POUR ACID INTO WATER AND NEVER ADD WATER TO AN ACID.	
10. Enamel copper and other types of non-ferrous metals.	Through literature and demonstration, expose the students to the enamelling process. Explain that metal enamels are low-fusing coloured glass powders that have been formulated to approximate the expansion and contraction rate of specific metals such as copper, silver, and steel.	
11. Solder different types of non-ferrous metals.	Review soft soldering and hard soldering.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
12. Select cutting compounds for buffing wheels.	Obtain several commercial buffing compounds and demonstrate their order of use on the buffing wheel. Discuss the following chart: Materials for Buffing Metal	Common Compounds 1. Pumice 2. Tripoli 3. Rouge 4. Rottenstone 5. Whiting
13. Buff metal on a buffing wheel.	Emphasize the importance of holding the work lightly against the face of the wheel, a little below the centre.	Metal Finishing Processes 1. Polishing 2. Flame colouring 3. Oil finishing 4. Paint finishing 5. Enamelling 6. Powder finishing 7. Antiquing 8. Wax finishing 9. Distress finishing (Wrinkling)
14. Finish metal surfaces.	Have each student select an appropriate finish for his or her product.	

Name	Use	Source	Color
pumice	for smoothing and cleaning, also for cutting down and polishing	powdered lava	white
tripoli	for polishing brass, copper, aluminum, silver, gold, platinum	decomposed limestone	yellowish brown
rouge	to burnish or produce a high color or luster	red iron oxide	red
rottenstone	for polishing precious stones, soft metals	decomposed shale	reddish brown or grayish black
whiting	for final polishing	calcium carbonate (pulverized chalk)	white

ADVANCED WELDING ME-13

Major Objective: To acquire knowledge and skill related to advanced welding and to become aware of current welding and cutting methods used in industry.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	It is recommended that Basic Arc Welding (ME05) and Basic Oxy-Acetylene Welding (ME06) be a pre-requisite to Advanced Welding (ME13).	
A. OXY-ACETYLENE WELDING The student should be able to:		
1. Recognize the safety aspects pertaining to oxy-acetylene welding.	Review and emphasize the importance of safety rules.	
2. Review basic oxy-acetylene welding.	With the aid of transparencies, handouts, etc., review pertinent information that may apply to the procedures covered in basic oxy-acetylene welding.	
3. Weld basic joints in the vertical position.	Practice welding basic joints in the flat and horizontal positions. Demonstrate proper procedures for vertical oxy-acetylene welding.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Weld basic joints in the overhead position.	Demonstrate this procedure outlining the following: a) safety considerations, b) torch and metal positioning, c) tip size, d) pressure, e) type and kind of filler rod used.	
5. Weld heavy plate in the vertical position.	Demonstrate oxy-acetylene welding of plate stock with reference to the following: a) metal preparation, b) metal positioning on a jig, c) tip size, d) pressure, e) type of filler rod used.	
6. Cut heavy plate using a cutting torch.	Review the set-up for metal cutting. Have students practice cutting a 90 degree angle and a 45 degree bevel on a half-inch thick plate.	
7. Perform silver-soldering techniques.	Point out that the oxy-acetylene torch, with heat approximately 6000 degrees F, must be used with extreme care when hard soldering.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. ARC WELDING The student should be able to:		
1. Recognize the safety aspects pertaining to arc welding.	Review basic arc welding safety objectives.	
2. Review basic arc welding.	Review the theory and techniques of basic arc welding. Have students apply skills obtained in basic arc welding.	
3. Arc weld basic joints in the vertical position.	Discuss and demonstrate the use of jigs, metal preparation and arc welding in a vertical position.	
4. Arc weld basic joints in the overhead position.	Discuss and demonstrate the following: a) metal preparation, b) jig setting, c) proper amperage, d) proper angle, e) proper rod, f) proper rod manipulation.	
5. Weld a multiple-pass weld in the vertical position.	Using a suitable electrode demonstrate the proper procedure for this objective.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Weld a multiple-pass weld in the overhead position.	Point out that a multiple pass weld is used to fill large V-shaped joints which cannot be filled with only one bead of welding. Use illustrations to demonstrate beads and weaves.	
7. Review arc welding defects.	Using examples of prepared welds, point out common weld defects associated with arc welding. Make reference to charts identifying common weld defects.	
8. Define hard-surfacing.	Discuss with students the purpose of hard-surfacing steel and give several examples where it can be applied.	Hard-Surfacing The application to a piece of metal of a coating or a surface that is harder than the base or parent metal.
9. Prepare metal for hard-surfacing.	Demonstrate metal preparation for hard-surfacing.	
10. Apply hard-surfacing to mild steel.	Demonstrate rod application and allow the student practice time.	
11. Understand how metal alloys may be arc welded.	Explain and demonstrate how alloys such as cast iron, stainless steel, aluminum, and other types can be arc welded.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
C. METAL INERT GAS (MIG) WELDING The student should be able to:		
1. Explain MIG welding.	Explain and discuss the principles of metal inert gas (MIG) welding. Gas-metal-arc welding is done with the heat of an electric arc formed between the workpiece and a consumable electrode. No flux or coating is used on the filler metal and the welding takes place in a "shield" of gas that protects the metal from the air.	
2. List advantages of MIG welding.		Advantages 1. Little cleanup 2. Greater speed 3. Possible to weld thin stock 4. Less distortion 5. Deep-penetrating characteristics
3. Identify MIG welding equipment.	Use charts and transparencies describing MIG welding equipment.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Display a knowledge of the wire-feeding mechanism.	Point out that MIG welding can be completely automatic or semi-automatic. When semi-automatic, the wire feed, power setting, and gas flow are pre-set, but the torch is manually operated.	
5. Understand the purpose of the shielded gas used in MIG welding.	There are several inert gases used for MIG welding. Have the students list these gases, giving a brief description of each. The most common gases are: a) helium, b) argon, c) carbon dioxide.	
6. Prepare basic metal joints for MIG welding.	Have the students prepare butt, lap, tee, corner, and edge joints in the flat position using the MIG welding equipment.	
7. Select proper welding current for welding.	Prepare a chart/table outlining metals, gauges, and temperatures required for welding each. Display the chart/table near the MIG welding machine. Point out that different welding currents have a large effect on the results obtained in metal inert gas welding.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
8. MIG weld basic joints.	Demonstrate welding basic joints with reference to the following: a) wire speed, b) height of arc length, c) gas pressure, d) amperage, e) angle of gun, f) direction of travel, g) speed of gun travel.	
9. Identify MIG welding defects.	Prepare several examples so the students may recognize defects such as lapping, surface porosity, cracking, and penetration.	MIG Welding Defects 1. Cold lapping 2. Surface porosity 3. Cracking 4. Poor penetration 5. Excessive penetration

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
D. TUNGSTEN INERT GAS (TIG) WELDING The student should be able to:		
1. Explain TIG welding.	Explain and discuss the basic principles of tungsten inert gas (TIG) welding. TIG welding is done with the heat from an electric arc discharged between the work-piece and a non-consumable electrode made of tungsten. A shield of inert gas is maintained around the arc and no flux is used.	
2. Understand basic terminology applied to the gas tungsten arc process.	Point out that after World War II, with non-ferrous metals more in demand, many gas tungsten arc welding (GTAW) processes were developed under different names such as TIG (tungsten inert gas), heliarc and argon arc.	
3. Identify tungsten arc equipment.		Basic Equipment 1. Arc welding machine with cables 2. Inert gas supply with hose and regulators 3. Water supply 4. Torch to which all of above arc connected

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
E. INDUSTRIAL WELDING PROCESSES The student should be able to:		
1. Describe electron beam welding.	By means of individual or group assignments, films, filmstrips, charts, etc., acquaint the students with current industrial welding processes. Have each student present a research report on one of the industrial welding processes identifying applications, advantages, disadvantages, etc.	
2. Describe inertia welding.		
3. Describe laser welding.		
4. Describe plasma welding.		
5. Describe ultrasonic welding.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
F. INDUSTRIAL CUTTING PROCESSES The student should be able to: 1. Explain the arc electrode cutting method. 2. Describe the powder cutting method. 3. Describe the plasma cutting method. 4. Understand the air carbon arc cutting method.	Discuss and explain that many welding processes are utilized by industry for material separating as well as joining metals. By means of individual or group assignments, films, filmstrips, charts, etc., acquaint the students with industrial cutting processes. Have student teams present research reports on industrial cutting processes, explaining applications, advantages, disadvantages, etc.	

ADVANCED MACHINE TOOL TECHNOLOGY ME-14

Major Objective: To gain additional knowledge and skill in machine tool technology with specific emphasis on the lathe and milling machines.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	It is recommended that Basic Machine Tool Technology (ME04) be a pre-requisite to Advanced Machine Tool Technology (ME14). Related and relevant information such as mathmatics, blue-print reading, measurement, etc., should be introduced concurrently with the topics in this module.	
A. INTRODUCTION The student should be able to:		
1. Understand safety in respect to various machine tool operations.	Review the safety considerations covered within the basic machine tool technology module.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. DRILLING The student should be able to: 1. Define countersinking, counterboring, reaming, and tapping.	Review the factors that affect cutting speeds and tool bit geometry.	Countersinking A way of machining a cone-shaped recess at the outer end of a hole. Counterboring Enlarging the outer end of a hole to a flat bottom. Often used to recess a bolt head below the surface of a work-piece. Reaming A method of finishing a hole to exact size with a very smooth interior surface. Tapping A process of producing threads in holes using a tap as a cutting tool.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Identify tools for counterboring, countersinking, reaming, and tapping.	Discuss and explain the purpose and applications of counterboring, countersinking, reaming and tapping. Demonstrate the above operations.	
3. Identify industrial applications of the drilling process.	Using visual aids, discuss and describe industrial drilling operations such as turret drilling, radial drilling, multiple spindle drilling, etc.	
4. Understand the principles and procedures of off-hand drill grinding.	Make students aware of the principles and procedures of off-hand grinding a twist drill bit.	
C. GRINDING The student should be able to:		
1. Identify industrial applications of the grinding process.	Using visual aids, discuss industrial applications of grinding such as: a) precision grinding, b) cylindrical grinding, c) centerless grinding, d) internal grinding, e) surface grinding.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Identify different types of hand-held grinders.		Portable Grinders 1. Dremel tool 2. Tool and die 3. Angle 4. Vertical 5. Straight
3. Perform operations safely using hand-held grinders.	Demonstrate grinding operations using dremel tool grinders, tool and die grinders, and body grinders. Discuss and emphasize safety precautions.	
4. Understand abrasive cut-off operations.	Point out that abrasive cutting falls into two classifications--dry and wet. Wet abrasive cutting, while not quite as rapid as dry cutting, produces a finer finish and permits cutting to closer tolerances.	
5. Perform operations safely using abrasive cut-off machines.	Emphasize the use of eye protection equipment.	
6. Mount and test grinding wheels.	Emphasize the importance of selecting a grinding wheel recommended for the material to be ground.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
D. LATHE TURNING The student should be able to:		
1. Identify the shapes of lathe-cutting tools.	By means of mock ups, charts, and discussion, emphasize that different tool bits are needed to do certain machining operations. Most tool bits are ground to cut in one direction only and the two common types are referred to as right cut and left cut.	Common Shapes of Tool Bits 1. Roughing Tool 2. Finishing Tool 3. Round-Nose Cutting Tool 4. Square-Nose Tool 5. Cut-Off or Parting Tool 6. Side-Facing Tool 7. Threading Tool
2. Grind a lathe tool bit for roughing mild steel.	Emphasize the following cutting tool features: a) side clearance angle, b) end clearance angle, c) back rake.	
3. Grind a lathe tool bit for finishing mild steel.	Using wood, have the students practice grinding various lathe tool bits.	
4. Sharpen lathe-cutting tools.	Students in the advanced machining program should be capable of sharpening or touching up an existing machine cutting tool. Have students determine where the cutting edge should be and the cutting angles recommended for specific operations.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Identify the different types of lathe chucks.	Have the students identify the universal, independent collet, and Jacobs chucks.	
6. Mount and remove different types of lathe chucks.	Discuss and demonstrate the use of the following chucks: a) Jacobs chuck, b) Independent (4-jaw), c) Universal (3-jaw), d) Collet chuck.	
7. Mount stock in a four-jaw chuck.	Demonstrate how a piece of round stock is centered in a four-jaw chuck. The use of a dial indicator may be helpful with this procedure. Discuss alignment procedures.	
8. Calculate cutting speeds for basic ferrous and non-ferrous metals.	Emphasize factors which should be considered when cutting into different metals: a) material, b) finish, c) cutting fluid, d) shape of material, e) condition of lathe.	Formula $RPM = \frac{CS \times 4}{D}$ Where: RPM = revolutions per minute CS = cutting speed of the particular metal being turned in feet per minute or millimeters per minute D = diameter of the workpiece in inches or millimeters

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
9. Turn metal stock to a shoulder.	Point out that whenever more than one diameter is machined on a shaft, the section joining each diameter is called a step or shoulder. Have the student do at least two of them.	Type of Shoulders 1. Square 2. Filleted 3. Chamfered
10. Use a parting tool.	Demonstrate how to use a parting tool. Emphasize: a) tool centering, b) type of material cutting, c) speed, d) rate of the depth of cut.	
11. Cut tapers using the offset tailstock method.	This machining operation involves careful set-up as well as the application of basic shop math. Using your text as a guide, demonstrate the procedures involved for cutting a taper using the offset tail-stock method. This method should be incorporated in a small project such as a hammer handle, punch, etc.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
12. Cut tapers using a taper attachment.	Taper can be cut on a lathe by using the taper attachment, offsetting the tailstock, and by setting the compound rest to the angle of the taper. Demonstrate taper cutting with use of a taper attachment.	
13. Cut tapers using the compound rest.	Review the basic machine technology for cutting tapers using the compound rest.	
14. Describe thread forms.	There are five basic thread forms used in machining. In most cases, it is not practical for the students to be able to cut all forms. However, they should be informed of the threading operations and be familiar with the American National.	Thread Forms 1. American National 2. Unified screw 3. Acme 4. Square 5. International metric 6. ISO metric
15. Perform thread cutting operations on the lathe.	Demonstrate proper procedures for setting up and cutting threads on a lathe. Point out the following operations: a) cutting left-hand threads, b) cutting right-hand threads, c) cutting the thread dial, d) setting the cutting and travel speed, e) setting the quick-change gear box.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
16. Define <u>boring</u>.	Point out that to be done successfully, boring must be done at low RPM with automatic feed and that the workpiece must be clamped solidly to the machine table.	<u>Boring</u> An operation done to produce a very straight hole to accurate dimensions.
17. Perform boring as an operation on the lathe.	Demonstrate to the students how to drill a larger hole by using the metal lathe and enlarging that hole by performing boring as an operation on the lathe.	
E. MILL MACHINING The student should be able to:		
1. Mill a slot or keyway on the milling machine.	Using a Woodruff key cutter, demonstrate how to mill a slot or keyway on a piece of stock on a milling machine. This operation may also be done on a horizontal mill.	
2. Machine a block square and parallel.	A definite sequence of operations must be followed in machining several surfaces of a piece square with one another. Use illustrations and demonstrate these operations.	

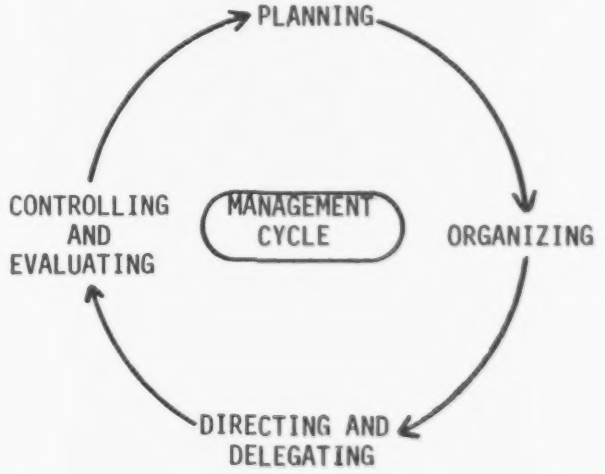
OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Perform drilling operations on the milling machine.	Demonstrate to the students how to set up a Jacobs chuck on the machine spindle for the purpose of drilling. Keep in mind: a) size of drill to be used, b) kind of material, c) kind of lubricant.	
4. Understand the purpose and use of the dividing head.	Demonstrate to students how the dividing head operates and explain its many uses.	
5. Understand the procedure for cutter and milling machine maintenance.	Emphasize to the students the proper need for cutter and milling machine maintenance. Demonstrate proper cleaning and oiling procedures.	
F. SHAPING The student should be able to:		
1. Identify industrial applications of the shaping process.	Using visual aids, discuss industrial applications of the shaping process. Point out that the planer has been largely replaced in mass production by the planer-type milling machine.	

MODERN INDUSTRY ME-15

Major Objective: To develop an understanding of the enterprise system and the principles and influence of mass production, to apply these principles and procedures to the manufacture of product(s), and to gain insight to current and future technology in the metalwork industry.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. ENTERPRISE SYSTEM The student should be able to:		
1. Define enterprise system.	Have students discuss and define enterprise system. Point out that Canada's economic system is a mixture of private and public enterprise.	Enterprise System An economic system related to business ownership.
2. Understand the various systems of business organization.	Emphasize that the size of business determines, to a considerable extent, the way the business is organized, and that a business or company can be owned by different numbers of individuals in accordance with various ownership systems. Have students define the various systems of business ownership: a) proprietorship, b) partnership, c) corporation, d) cooperative, e) crown corporation.	Proprietorship A system of ownership where one person owns and operates the business/company. Partnership A system where two or more owners are responsible for the operation of the company. Corporation A business organization in which shareholders own the company and an elected board of directors is responsible for the operation. Cooperative A business organization owned by its customers.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
		Crown Corporation A business organization in which the people of a province/country own a portion of the company.
3. Identify the five divisions of an industrial organization.	Point out that most large organizations consist of five divisions and that the success of a company depends upon the operation of these divisions. Emphasize the direct relationship of research and development to manufacturing and to marketing. Explain how finance and control and industrial relations provide support for all the activities of a company, and that each of the divisions is necessary for efficient operation.	Divisions of Industrial Organization 1. Research and Development 2. Manufacturing 3. Marketing 4. Industrial Relations 5. Finance and Control
4. Explain the responsibilities of each of the divisions of an industrial organization.	Use charts and illustrated reports to acquaint students with these responsibilities: a) Research and Development - working with ideas to create new products and developing knowledge about the materials and processes used by the company. b) Manufacturing - obtaining materials and setting up machines for production, planning, organizing, controlling production, and maintaining the production plant.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	c) Marketing - selling the product, looking for new product ideas/new markets, planning for sales, advertising, and distributing. d) Industrial Relations - dealing with the hiring, training, retraining, job satisfaction, and firing of employees. e) Finance and Control - obtaining and controlling money needed to operate the business and to purchase supplies and materials for the company.	
5. Explain the components of the management cycle.	Discuss the diagram of the management cycle and have students define each of the management functions.  	Planning The process of setting goals and developing a plan of action for reaching goals. Organizing The assignment of people and facilities to accomplish goals. Directing The process of telling and showing people how to do a job. Controlling The process of insuring that results are in line with the company goals and objectives.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Describe the basic M's of a manufacturing corporation.	Have students identify and describe how the basic M's are related internally and to the management cycle. Make students aware of these concepts: a) Money - Expenses of a company are usually divided into two major catagories--working capital and fixed capital. Working capital is money used to purchase raw materials, pay workers' salaries, pay taxes, and purchase miscellaneous company and employee needs. A company must have either an adequate supply of money or a close working relationship with financial institutions. Discuss with students what companies would purchase with fixed capital. b) Machines - If the products are to be competitive in quality and price, they must be produced by tools and machines which are up-to-date. c) Material - Companies must have adequate supplies of all parts which make up the products. d) Men and Women - Point out that industries need workers who are willing to produce quality products efficiently. Discuss the relationship of technology -- automation, computers, robotics - to efficient production and quality of products.	Basic M's of a Manufacturing Corporation 1. Money 2. Machines 3. Material 4. Men/Women 5. Methods 6. Markets 7. Management

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	e) Methods - Discuss numerically controlled and computer-controlled processes in the development of new and better methods for producing products and for using raw materials. f) Markets - Point out that markets include how and where the company sells its products. g) Management - Review the concept that management must plan, organize, direct, and evaluate the tasks of a company. Discuss the relationship of money, machines, materials, men and women, methods, and markets to management.	
7. Explain the procedures for incorporating a company.	Discuss incorporation procedures with the students. Invite representatives of industry, and government, to explain various aspects of incorporating and operating a business. Point out that a corporation is probably the best type of business organization for an industrial arts class to form for manufacturing a product(s).	
8. Organize an in-school company to manufacture a product.	Have students role-play the steps to incorporate a company for the production of a product. Assist students with the preparation of estimates and budgets for all facets related to the manufacture of the product.	

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. MASS PRODUCTION The student should be able to: 1. Define mass production.	Point out that because human wants and needs have increased, techniques and procedures leading to mass production have been developed to produce large quantities of items quickly and inexpensively. To aid students in developing an awareness of mass production, have them participate in activities like these: a) view films on maufacturing to identify the principles; b) visit manufacturing plant(s) to see how the principles are applied; c) assess the applicability of these principles to today's industry; d) discuss the influence of computer technology, robotics, etc., on mass production.	Mass Production A system to make standardized or interchangeable parts and which divides labour among many people.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Identify the fundamental principles of mass production.	Discuss the principles of mass production developed by Henry Ford and Eli Whitney. Ford's Principles 1. Duplication of parts makes interchangeability possible. 2. Each worker has a specific job to perform. 3. Wasted motion and wasted time are eliminated. 4. Conveyers bring parts to and from workers. 5. Tools, equipment, and workers are arranged in order of operations needed for assembly. 6. Travel distances for parts and such assemblies are kept as short as possible. Whitney's Principles 1. Each machine can be set up to do a specific operation. 2. Parts can be machined accurately. 3. Parts can be assembled quickly. 4. The system requires less skill on the part of workers. 5. Much time is saved in the production of parts. 6. Each part reproduces similar parts and can be interchanged, reducing assembly costs. 7. The system reduces costs and increases efficiency.	Fundamental Principles of Mass Production 1. Development of specialized machine tools 2. Use of transfer machines 3. Use of jigs, fixtures, and dies 4. Interchangeable parts manufacture 5. Quality control

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	8. Tooling-up requires time and risk on the part of the manufacturer.	
3. Describe the influence of mass production on society.	Have students discuss and debate positive and negative influences of mass production, i.e: a) decrease in production costs; b) increase in industrial growth in Manitoba, Canada, the United States and other countries; c) change in lifestyles - mass consumption (many people buying and using products), - division of labour system in the workplace, - increased leisure time, - under-employment, - unemployment, - effects on environment.	
4. Identify the basic production resources for industry.	Have students prepare reports to increase their understanding of the essential resources for industry: a) Natural Resources - the raw materials from which people make the goods they need, i.e., wood, metal, plastic, ceramics, water, earth, air, chemicals, etc. Emphasize the importance of conserving and use natural resources wisely.	Basic Production Resources 1. Natural Resources 2. Human Resources 3. Energy Resources 4. Equipment Resources

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	b) Human Resources - the people who design, make, sell, and maintain the products. c) Energy Resources - the necessary power requirement to operate machines and factories, i.e., electricity, gas, oil, gasoline, atomic energy, solar energy, etc. d) Equipment Resources - the tools, machines, factories, and transport systems used to process raw materials into useable goods.	
5. Describe the basic steps requisite for planning a manufacturing mass-production system.	Emphasize that an important challenge in manufacturing is to plan a system to produce the required number of products in the shortest amount of time, and that planning, basic to manufacturing, is a prerequisite to mass production. Have students participate in various teaching-learning activities related to the following steps: a) Identify consumer demand - Point out that manufacturing companies must find out what people want, to ensure that products will sell. b) Designing and engineering products - Emphasize that apart from considering how well a product will work, small details must also be considered (for example, how it will look, its shape, colour, size, etc.). In industry, designing and engineering can take many	Basic Steps for Planning a Manufacturing Mass-Production System 1. Identifying consumer demand 2. Designing and engineering products 3. Planning production 4. Tooling-up for production 5. Planning quality control

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	years before an acceptable product is developed. c) Planning production - Point out that for production, all details must be determined before production starts. Questions as follows must be considered: How many products will be made? Which parts will be purchased? Which parts will be made? What about machines? What about people? d) Tooling-up for production - Emphasize that tools and machines must be in the right locations and that jigs and fixtures are a very important component of this stage. e) Quality control - Emphasize that the success of a manufacturing company product depends upon the planned checks built-in.	
6. Understand the principles of jig and fixture design.	Emphasize that jig and fixture components used in mass production tooling processes allow for production of duplicate parts, thereby increasing production rates. Discuss the following features related to jig and fixture design: a) workpieces can be clamped securely; b) jigs and fixtures can be securely affixed to tables so as not to move or vibrate; c) jigs and fixtures can be easily removed; d) jigs and fixtures should be safe and easy to operate;	Jig and Fixture Design, Delmar Publishing Jigs and Fixtures, Module XIII, Industrial Arts 7-9 Manufacturing

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	e) chips from drilling and cutting can be easily removed.	
7. Produce a product by applying the principles of mass production.	Review with students the principles of mass production, the elements of industry, and the basic steps requisite to planning a manufacturing system for mass production in the industrial arts lab. Select a product, plan the layout of the industrial arts lab, develop production flow charts, select materials, tools, machines, etc., develop jigs and fixtures, assign tasks, trial-run to analyze the flow of work and operation of the production line, and produce the product.	
C. ROBOTICS The student should be able to:		
1. Understand the history of robotics.	Have the students do a book report on one of Isaac Asimov's books which has robots in it. Tell how closely the robots in his book compare to the robots of today.	Michigan State Industrial Arts Curriculum: Robots, Michigan State Board of Education Robotics and Industrial Electronics, Heath Company Robots, An Introduction to Basic Concepts and Applications, Midwest Sci-Tech Publishers

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
		Industrial Robots, Fundamentals Vol. I and II, 2nd edition, Published by Robotics International Society of Manufacturing Engineers What Every Engineer Should Know About Robots, Marcel Dekker Inc.
2. Define a robot.	Have students prepare their own definition of robots. Compare their definition with that of the Robot Institute of America.	Robot A programmable, multifunctional manipulator designed to move materials, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks. - Robot Institute of America

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Differentiate among industrial, training, and personal robots.	Point out that robotics is a growing industry with new designs for robots and new manufacturers constantly appearing on the market. Have students identify operations designed for robotic use in factories, schools, and homes. a) Factories - Robots are used for tasks that are generally boring or dangerous for humans to perform, e.g.: - spot welding, - seam welding, - assembly of circuit boards, disc drives, color ribbon cassettes for typewriters, - weaving wiring harnesses for automobiles, - dip soldering automobile parts, - loading newly made bricks onto pallets, - applying adhesives to glue parts together. b) Schools - The robots used in education and training programs are smaller, less expensive and mechanically simpler than their industrial cousins, and are meant for demonstrating the basic principles of robot design, operation, and control. c) Homes - The personal robot is perhaps the most technologically sophisticated type, capable of talking, moving from room to room, detecting body heat, detecting motion, sensing light and sound, etc.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Understand robot-classification systems.	Point out a robot basically consists of a manipulator, a controller, and a power supply, and that various classification systems use these components as their bases. Discuss the following methods of classifying robots: a) level of technology; b) electromechanical controls ("servo" and "non-servo"); c) instruction-receiving ability (sequence, track, registration and information); d) primary motions that a moving part can take; e) basic configurations the robot can take in its work envelope.	
5. Explore the socio-economic factors of robotics.	Have a class debate on the benefits vs. the threats of industrial robots to the Canadian worker. Point out that robots are being used in increasing numbers for operations in environments that humans cannot work or in which they don't want to work. Discuss this excerpt from an advertisement: "Wanted: Jobs nobody wants. Every plant has its share: boring, repetitive, backbreaking, often in noisy, dirty, or dangerous environments".	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Understand the basic drive systems used to operate a typical industrial robot.	Emphasize that a drive system is required for each degree of freedom the robot is designed with; that the application determines the robot to use; and that generally the robot used determines the drive system, i.e., electrically operated robotics cannot be used for spray-painting applications because of the danger of highly volatile fumes being ignited by electrical motor arching. Discuss the various features and operations of robot drive systems, with review of the uses of simple machines in robots. Point out why electro-mechanically driven robots are now the fastest-selling robots in the industry, i.e.: a) excellent in acceleration, deceleration and velocity control; b) excellent reliability records; c) capable of very precise movements and tight control; d) motors work easily with digital-type input signals.	
7. Understand the mechanisms which impact and control robot motion.	Point out that controllers are the brains of the robotic system, starting and stopping the motions as well as keeping track of the robotics position and sequence of operations. These could be as simple as a push button or as complex as a mini-computer.	Open Loop System A robotic control system in which input instructions to the robot do not depend upon any feedback from the manipulator.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	Point out that robotic controllers can be put into two categories: the open loop system and the closed loop system, and describe each.	Closed Loop System A robot-control system in which input instructions to the robot depend upon feedback from the manipulator.
8. Understand the factors used in planning a robot installation.	Point out to students that robots don't suddenly appear at a factory or industrial plant and ask for a job. Instead, a careful planning process must be followed to determine the exact application of the robot, the economic justification of the installation, and the long-term usage of the robot. Discuss the following factors for determining the use of robots in an industrial setting: a) complexity of the operation - operations that involve judgment, combinations of sensors, and manipulation should be avoided; b) degree of disorder - parts or materials must be in appropriate position and orientation; c) production rate - cycle time for the operations must be determined and compared to human productivity; d) production volume - batch size/single part manufacturing must consider flexibility and potential obsolescence of robots vs. fixed automation and people;	Factors used in Planning a Robot Installation 1. Repetitive routine 2. Multi-shift operation 3. High volume output 4. Hazardous conditions (for humans) 5. Strenuous or tedious job 6. Simplicity requiring few modifactions 7. Low cost of additional support equipment

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	e) justification - economic support is necessary; will the application save money?; f) long-term potential - the number of applications and their duration must be balanced with the useful life expectancy of the robot; g) acceptance - human attitudes must be known and channelled appropriately.	
9. Identify the safety aspects surrounding the robot and how they affect robots and humans.	Point out that the robot was designed to take the place of boring and hazardous jobs, but it also created new hazards, e.g.: a) trapping points - caused by two or more moving objects in the same area at the same time; b) impact - being struck by the robot or being struck by an object carried by, dropped, or thrown by the robot; c) electric shock, burns, arc flash, sparks and toxic substances attributed to control errors, unauthorized access, lack of respect, and human error. One thing we must remember is that safety devices can be implemented to protect persons in the environment, but the danger still exists.	

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	Have students identify and describe the hazards in the environment for the human and the robot; i.e.: a) temperature - radiant heat from areas such as open furnaces and hot parts can be damaging to both human and robot; b) shock and vibration - hammer forging can be harmful to humans' ears but the shock and vibration could also disrupt the operation of the robot; c) electrical noise - electrical noise may affect computer controllers which would then interrupt programming signals and change the robot's operation; d) liquid sprays & gases - contaminated areas with paint spray and poisonous fumes may cause lung damage to humans; however, these same contaminants may float through the air and settle on the robot switch areas to cause malfunctions; e) particles - grinding sparks and flash could be dangerous to the human eye. Particles as these could be corrosive, settling and building up on robots and thereby causing malfunction; f) fire/explosion - if flammable material is in the area, care must be taken that the robot does not create a mechanical or electrical spark that may cause an explosion.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	Emphasize the fact that accidents cannot be prevented by safety devices alone. One should learn not to assume anything - because a robot isn't moving when you first see it doesn't mean that it wouldn't ever move.	
Identify potential careers in the area of robotics.	Have students research career opportunities related to the "robot team" along with the kind of training needed. Discuss these positions: a) engineer - a "behind the scene" member seeking ways in which to design, build, and utilize robots for improved productivity, quality, safety, and cost saving. A degree would be required; however, you would work with the overall manufacturing process and would have the option to easily climb the corporate ladder; b) technologist/technician - these are the "doors", the "hands-on" members who would implement the ideas as well as improve them; c) maintenance/service workers - individuals responsible for the set-up and service calls on the robot system; d) sales engineers - personnel trained in marketing and business administration, with ability to present a technical analysis of how the product works, what product is best suited for the plant	Careers in the Robotics Field 1. Engineers 2. Technologists/Technicians 3. Maintenance/Service Workers 4. Sales Engineers 5. Technical Educators/Trainers

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	operation, and the productivity and quality to be experienced; e)technical educators/trainers - a variety of educators and trainers is needed to prepare people to understand, install and service the quickly developing complex machinery. Teachers are needed on the plant level, in colleges, universities, and technical and vocational schools.	
D. ADVANCED INDUSTRIAL PROCESSES The student should be able to:		
1. Develop a list of advanced processes in the metalwork industry.	Involve students in research activities to develop their awareness of advanced processes in the metalwork industry. Some discussion topics could be: a) Electrical Discharge Machining b) Chemical Machining c) Ultrasonic Machining d) Electronmechanical Machining/Grinding e) Electron Beam Machining/Welding f) Laser Beam Machining/Welding g) Computer-Assisted Machining h) Numerical Control i) Explosive Forming	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Present a technical report.	Have students prepare and present a technical report on an advanced process as listed above or another advanced process in the metalwork industry.	

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METALWORK 101, 201, 301

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	GENERAL METALS	MODERN METAL-WORKING	WELDING	WELDING PROCESSES & PRACTICES	MACHINE SHOP TRAINING	MACHINE TOOL METAL-WORKING
	Units	Units	Chapters	Units	Chapters	Sections
01 Student Orientation and Safety	1,2	1,4				
02 Product Planning	3,4,6,8	3				
03 Measurement & Use of Instruments	5,9,10	5,6,7				
04 Basic Machine Tool Technology	13,14,19, 60-68	21-24,26			1-14	1,5-9
05 Basic Arc Welding	72,74	18	1,2,10-13	12,14,15		
06 Basic Oxy-Acetylene Welding	72,73	17,18	3-5,7-9	1-8		
07 Sheet Metal	7,11, 24-35	7,8,17, 20				
08 Bench Metal	7,11, 12-23	7,8,9,10, 20				
09 Foundry Practice	57-59	13,14				
10 Forging Practice	54-56	15,16				
11 Metallurgy & Basic Heat Treatment	7,69-71	1,2,19				
12 Art Metal	36-49	8,12				
13 Advanced Welding	75-76	---	6,14-17	8-11,13,16-20		
14 Advanced Machine Tool Technology	63-68	21-27			1-14	1,5-9
15 Modern Industry	77-86	1,30-33				

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2678	Between The Rails (Railroads - Employees; Locomotive Engineers; Railroads - Dieselization)	7 - 12
3358	Blue Collar: Steel Workers (Iron and Steel Workers)	10 - 12
2393	Boring and Drilling Tools (Drilling and Boring)	4 - 12
1799	Decorative Metal Work--The Making of an Etched Bracelet (Art; Metalwork; Handicraft)	10 - 12
1393	Elements of Hardening (Steel-Quenching; Steel - Heat Treatment)	7 - 12
1394	Elements of Surface Hardening (Steel - Heat Treatment)	10 - 12

2549	Elements of Tempering, Normalizing and Annealing (Steel - Heat Treatment)	7 - 12
1698	Files (Metalwork; Tools; Files and Rasps)	7 - 12
3557	Files and Filing (Files and Rasps; Hardware)	7 - 12
4164	Is A Career In Machining For You (Machine Shop Vocational Guidance)	7 - 12
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